PRACTICAL POTTERY

The Metropolitan Museum of Art

A Greek vase from the fifth century B.C. This kalyx krater is red figured and the decoration represents the battle of the Greeks and Amazons.

PRACTICAL Pottery

FOR CRAFTSMEN AND STUDENTS

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TO MY FRIENDS AND STUDENTS

Introduction

POTTERY is one of the most satisfactory crafts for schools or amateur practice, because one may begin in the most medieval way with clay of his own digging, and get complete results at once with his own hands as tools. The moist clay attracts the fingers and educates them. Under instruction one can advance through the processes of building, casting, throwing, glazing, and firing in a single semester and so experience an entire industrial cycle from raw materials to many finished products. One may continue to any extent, as Professor Jenkins points out, but the sense of relative mastery and control of the whole product will always be present and will give an insight into the modern industrial world and its method of evolution from primitive needs and processes. Once having made pottery by the methods of the primitive craftsman, the washed clays and ground minerals and drudgery-saving machinery of the modern world may be used.

In this age of complex living and manufacture we become personally irresponsible and parasitic toward the execution of our material necessities. We seldom or never repair a punctured tire, but take it to the garage; the barber, and not mother or father, trims our hair; the radio, and not the talented daughter, gives us music; the baker makes our bread; the village dressmaker no longer gives individual service — the gown and hats for next season are already made and stored by the jobber. The opportunity for pleasure and discipline in individual creation and production is lost in many directions. Medieval industrialism is gone; we do not wish it to return, but the artist, which dwells in every human being, seeks to express himself by making some complete and beautiful object, be it a garment, a house, an implement, a garden, an article of furniture, a carving, or a drawing. Hence the value of the crafts in schools.

Professor Jenkins has written a book which in understanding of the topic, and in informational thoroughness has few equals in crafts litera-

ture. While having contributed but the slightest to his knowledge, I am quite proud to acknowledge him as a former pupil.

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Preface

IN A field bordering on many industries and with an almost ageless background, it is difficult to plan a book that will reach the desired end. From the nature of the material, the results must be obtained from both empirical and scientific study, and to write a book that will be helpful to the practical student and at the same time benefit the more finished craftsman, is the problem at hand.

In this period of history, when almost any business demands the outlay of large sums of money, clay working does have some encouraging aspects. An ambitious worker in this art can start with a small capital and grow with his business, and his product can be sold upon its own merits and is not dependent upon a nationally advertised name.

Although in some of our larger schools the elements of the ceramic arts are taught, there is still a large field for interesting study and a vast supply of inexpensive material at hand. The work has long been grouped in many schools as art alone, and has in this way been left out of the practical field where it belongs. It is true that there is a fine art in the work, but it is also an applied art, and therefore should be given place in industry.

There is a wide, unexplored realm for the capable teacher of industrial arts who wishes to go into ceramics. The material is plentiful and inexpensive, and the cost of equipment is no more than in any other line. In fact, with a little ingenuity, a large per cent of the equipment can be made so that the cost can be kept at a very low level. The work can be commended very highly for those who are looking for an opportunity for self-expression.

The production of pottery offers a most excellent opportunity not only for the beginner in school, but also for the young man or woman at home, who wishes to try out his or her hand as a craftsman. Here the worker can produce beautiful pieces and make the work self-supporting as it goes along.

The material in this book has been compiled to help beginners over some of the difficult places. A great deal of time has been spent to make the descriptions exact in detail and the illustrations numerous enough to leave little room for misunderstanding.

A brief historical sketch is given to create a suitable background for a study which always touches the intimate home life of a people and to give inspiration to the worker. The craft will always be full of alluring avenues to beckon the student, and after a lifetime spent in its study, he will in the end exclaim, "Alas, I have only just begun."

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PRACTICAL POTTERY

CHAPTER I

Historical Background

WHERE Found. The use of pottery is so intimately associated with the home life of all races, that to name the region of its origin would be impossible. Fragments of burned clay dishes, as well as complete pieces in good state of preservation, have been found in the buried ruins of homes and crumbling temples in many parts of the world. Remarkable pieces have been excavated from the tombs of Egypt. In fact, most of the ancient lands bordering upon the Mediterranean have given to the world excellent examples of the ceramic art. The simplicity and beauty of this early primitive ware should be an inspiration in this age of rapid commercial production.

How Discovered. Just how the discovery was first made that clay could be turned into a stonelike hardness is largely a matter of conjecture. It is more than probable that the fact was learned through some accidental means, and not by direct experimentation with clay. Perhaps some wandering tribe built its campfires on a clay bed and thus unknowingly learned that clay could be hardened with heat. Whatever the truth may be, the first pieces were formed by hand, and it was only as the work grew into a simple art after centuries of experience that the potter's wheel came into use. What a marvel the wheel was to those early simple folk, and what an inspiration to their love of form and beauty of outline! On the tombs of Beni Hassan (Thebes) in upper Egypt, on the east bank of the Nile, drawings dated about 2000 B.C. (18th Dynasty) have been found ~~showing the~~ potter's wheel in use. With the advent of the wheel, pieces were marked with a greater variety of interest and subtle charm.

During the nineteenth century it was thought that the Egyptians and Chinese should have all the credit for the beginnings of the pottery art. There are evidences, however, that wherever clay has been found,

some men have practiced the craft. It appears that wherever man has left evidence of an early civilization, simple, hand-built pottery was hardened by drying in the sun and was used as a storage receptacle for all sorts of dry products. By the use of fire, early races of men discovered that clay, when baked, became hard as stone. They also learned that certain clays did not retain the same color under the influence of heat, but that some turned different shades, particularly of red and black, and others remained white or gray.

Egypt. Red earthenware dishes were made by the Egyptians as early as 3000 years before Christ. From that early date onward there are evidences that the art grew in important ways. There are good reasons to believe that the Egyptians, early in their ceramic history, grew away from the use of ordinary colored clay decorations and developed brilliantly colored glazes and enamels so that their forms glowed with color and life. At times, however, their pieces were inclined to be rather heavy.

The many fine objects made of clay found in tombs and burial mounds show the rapid strides made by these people in the development of shapes of their pottery. They also indicate that considerable progress was made in the use of colored enamels and glazes. Many pieces of pottery, among them figures of gods and ushabti, were finished with such enamels and glazes.

It is interesting, too, to note that the glazes had an alkaline base which made severe demands upon their patience and skill and proved them to be real masters of their art. Some of the early glazes show the use of copper and iron for colorants, giving lovely shades of green and yellow. These glazes show that the Egyptians had some knowledge of chemistry at a time when chemistry was not known as a science. The finest displays of color in ancient pottery came later, and were the work of Persians and Syrians.

Greek Pottery. Greece, world-renowned leader in all the arts, seems to have developed the art of pottery somewhat later than Egypt and the Oriental countries. It is typical of Greece that, once the art was established, ware wonderful in form and decoration was produced. The early Greek pottery was made by hand in much the same manner as the ware of other nations, and even with the introduction of the wheel the processes of the Greek potters remained very simple in character. Yet, in the production of nearly perfect pottery no nation

The Metropolitan Museum of Art
Fig. 1. A Greek vase from the fifth century B.C. This kylix is red figured and is attributed to the painted Douris.

has ever excelled Greece. The finest Greek pottery was made shortly after Pericles, about the fifth century B.C., and was noted for its form and its figure painting.

Persia. The Persians produced pieces of pottery that have never been equaled by anyone in color or designs. Some of their outstanding pieces were painted in simple colors. The luster of their ware has never been surpassed and their shapes have always been most pleasing.

Rome. The earliest Roman pottery was black Etruscan molded ware, produced as early as the eighth century, B.C. From the sixth to the second centuries, many of the Roman vases were imitations of Greek ware. The most valuable of the fine work done in Rome was the Aretine or Samian ware which was a brilliant red with a thin glaze. The Romans first introduced the potter's wheel to western Europe. Since the Renaissance, Italy has produced fine majolica and faïence, and these wares were especially popular at the close of the fifteenth century.

MODERN DEVELOPMENTS

In any historic sketch of the development of the potter's art there are enormous gaps of time. In fact, a steady growth in the art cannot be traced in any country except perhaps in China. So far as Europe is concerned, the story has no worth-while facts to record until the rise of the Renaissance in Italy.

Spain. In the twelfth century the Moors produced beautiful pieces of pottery in Spain, known as the Hispano-Moresque ware noted for its luster. They also made plaques which were equally beautiful on the back and the front. The Moors were the first to use glazes with lead base.

Germany. Since the middle ages the Germans made excellent stoneware, ornamented with reliefs and colors. In the early part of the eighteenth century exceptionally fine figures were made of porcelain in Dresden, Germany.

Holland. In the early part of the seventeenth century, this country became known in the pottery world through its blue and white ware made at Delft.

England. Although the English people had been making pottery and porcelain ware for centuries, it was not until about the middle of the seventeenth century that their work became known throughout Europe. Some of their fine porcelain and earthenware have never been equaled.

In the field of pottery, the work of Josiah Wedgewood at Burslem, England, earned for him the name of "Prince of Potters." Wedgewood will ever remain one of the greatest masters in the field of ceramics.

China. The very mention of China as related to pottery gives a thrill to the student of ceramics. In this nation of quaint, old traditions, the production of pottery goes back into the dim shadows of the past, to about 3000 years B.C. Most of the ware which has survived from that early date seems to have been used as funeral urns. The pieces were made both by hand and on the wheel. This ancient pottery was pleasing and at times imposing.

At about 200 B.C., glazes were first introduced into China, but even then with the glaze the pieces were still artistically decorated in various ways of designs. Reading the records of the various dynasties gives us the story of wonderful achievement in the ceramic art. The world in many ways owes much to this quaint nation. It is said that there are cities in China whose very streets were paved with broken dishes.

The Difference Between Pottery and Porcelain. Pottery and porcelain might easily be discussed as one form of art, but it is probably best for the sake of accuracy to make clear the differences in these forms of ceramics.

Pottery is a product made from original materials as found in na-

ture. It is produced from pure clay as it is dug from the ground and has little or no additions in the way of foreign materials.

Porcelain, on the other hand, is a more or less artificial compound made up of several ingredients which pass under the designation of "paste." Pottery exemplifies strength, virility, and forcefulness; while porcelain is characterized by lightness, translucence, and delicacy of ornament and form.

Gombroon Ware. When porcelain was first introduced into England, it was known as Gombroon Ware because it was shipped principally from Gombroon, a trading post located on the Gulf of Persia. Later most of the porcelain was received from Canton, China, so that it gradually lost its original name and became known as chinaware. China, or chinaware, is thus simply another name for porcelain, and though porcelain is a product developed by some of the same processes as pottery, it is a product apart from and beyond pottery. China, the land of strange customs, where history is dimmed with age, and where beautiful products are found strangely mingled with abject poverty and dirt, seems to have been the original home of porcelain, the land in which it was first manufactured.

Chinese porcelain was introduced into Europe in the fifteenth century and was considered the very finest product of the potter's art. The oldest Chinese ware, though, does not have the refined qualities of that of later dates, and some authorities even think that it should not be considered strictly as porcelain, as it shows the use of coarser materials in the paste. However, near the close of the Lung Dynasty (A.D. 960–1279) a type of porcelain appeared which satisfies the taste of the most exacting judges. Unlike others who stressed translucency, the Chinese gave little thought to that quality; they valued much more highly the resonance of a piece. Some of the finest Chinese porcelain will, therefore, be found lacking in the quality of translucence. This is largely due to the thickness of the ware.

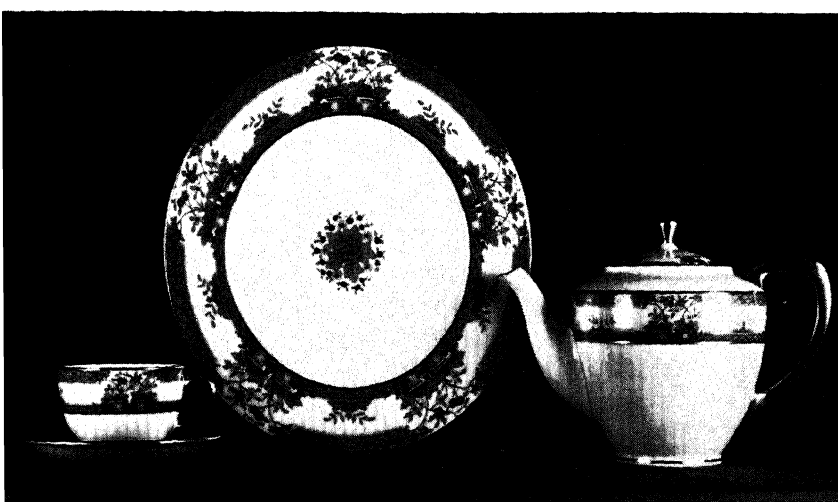
Undoubtedly Chinese porcelain was greatly improved by the nature of its glazes. The body being merely a medium for the expression of beauty through the work in the gloss furnace, color was applied in a variety of ways to enhance the beauty of the glazes and to produce a wider variety of the ware.

Chinese crackle glaze, held in such high esteem today, was in all probability the result of a glaze that did not work out as intended, but

cracked because it failed to unite evenly with the body of the piece. Crazing is not uncommon in the ceramic industry and usually demands of the producer a radical change in the composition of his glaze or the body of the ware. The Chinese, however, were farsighted, for they saw in this defect valuable possibilities. Out of a fault, they developed a product which later produced works of art. By careful experiments these glazes were developed into a variety of crackles which were classified into large, medium, and small. To accentuate still further the character of this type of glaze, different colors were rubbed into the cracks, giving to the ware a very decided character.

Many of the beautiful Chinese colors were the result of accidental discoveries and were later brought under the control of the potter through continued, careful work.

In practically every field of human endeavor there have been men who have stood out as leaders in the fight for the progress of the cause in which they were interested. The world owes much to those indomitable souls who blazed a trail that others might follow. The truth of this observation applies especially to the development of the art of the potter. There is inspiration in the story of the unnamed men who first perfected one detail and then another. Their stories are recorded for all



Lenox Inc., Trenton, N. J.

Fig. 2. Lenox porcelain. "The Monticello."

time in the magnificent collections of the European museums, and even in the great art collections of the larger American centers their stories may be traced. However, it is not the purpose of this book to give a history of pottery and porcelain, but rather in this short chapter to suggest the importance and interest of the subject.

Though for a long time it was claimed that American potters could not produce the best ware because our continent is geologically too young, we have many factories producing excellent porcelain and pottery. To mention only one of many recent producers of fine ware, it may be said that Walter Scott Lenox, at Trenton, New Jersey, in 1889 began the manufacture of china which was to rank with the finest porcelain anywhere. The first American-made dinner service to grace the White House was composed of 1700 pieces of Lenox porcelain. The story of Lenox's work and life is worth reading.

CHAPTER II

Clay and Clay Preparation

FROM the brief historical sketch in Chapter I, it may be seen that clay and its use in producing serviceable articles, has been the subject of observation and study for ages. In one short chapter of this book it would manifestly be futile to attempt more than a brief, practical discussion of its nature and use in pottery making. Numerous scientific and technical works are available for the potter who wishes to study the material upon which his craft depends.

Definition. When one starts to describe or define the term "clay," one thinks immediately of its main characteristics, that of plasticity. Clay is a material widely distributed throughout the world, and wherever found, plasticity is there in a greater or less degree. Generally speaking, clay is composed of small particles, nearly all of mineral nature, varying from microscopic size to coarse sand, and having a definite molecular attraction. The essential constituent of clay is hydrated silica of alumina, though with this may be found oxides, carbonates, and hydroxides of other elements in varying proportions, iron especially being present in many cases.

Hardly any material in nature offers a wider opportunity for study than clay, and few substances affect our daily life more intimately. The bricks and cement in our houses, the dishes we use, the papers we read, the insulators in our electric equipment, the sanitary fixtures of our plumbing, all are familiar examples of the common uses of clay. Thought of in such terms, clay no longer becomes a valueless compound.

Plasticity. Clay is the only material in nature which possesses plasticity in its natural state. Plasticity is that characteristic which permits changes in the shape of clay without breaking up and destroying the continuity of the material as a whole and permitting also the retention of the new form. Rubber, an artificial substance, has some of these

qualities but not all. Rubber will spring and give, but never retains its new shape unless held by some external means. Yet a lump of clay becomes almost alive in the potter's hands, responding to his every touch.

The longer it is considered, the more marvelous this plastic secret of nature seems. Molded and shaped by hand, clay responds to every whim of the worker, yet under the influence of intense heat, the molecular formation is changed and the plastic quality is gone forever. Grind the fired piece as long as one will, and reduce it once more to a powder as fine as in the beginning, yet no alchemy of the astrologer or skill of the scientist can ever restore this hidden quality. Plasticity has gone to join the secrets of the universe, and with those secrets lies another interesting phenomenon. A mass of clay can be analyzed so that its exact composition is known, and then from other sources a like mass collected. Grind up both batches to the same degree of fineness, add water, and the clay goes back to its plastic state while the collected mass remains so many lifeless particles. What plasticity is, then, we do not know. Many theories might be advanced, but the fact remains a secret which mother nature has hidden away until some future generation shall have grown to a point where such knowledge is possible.

Color-Formation-Variety. Clay very often contains a number of mineral oxides, the most common of which is some form of oxide of iron. This oxide may give the clay a yellow, brown, red, blue, or even a green color. These colorants, however, do not indicate that the clay cannot be used, as some very good pottery clay is far from being white. There are very few substances in nature which, when analyzed, vary in composition more than does clay. Clay is formed from the decomposition of rock and naturally contains, in some proportion, the materials from which those rocks were formed. However, the deposits are not always located in direct conjunction with the decomposed rock, so that minerals from other sources have become a definite part of the clay. Usually the chief source of clays in North America is the disintegration of granite and feldspathic rock, which explains the reason for the large supply of this material in clay. The kinds of clay, however, are very numerous so that one might list nearly two thousand varieties which show a difference by actual analysis.

Kinds of Clay. Clays are usually classified by (*a*) formation or

(*b*) location, and as the list is long, only two groups can be given here. The two most common types are residual and sedimentary. Residual clay is the residue of decomposed rock and will be found lying as a surface covering over the rock from which it was formed. It is very likely, however, not to remain in the place of its origin, but is carried away by floods and rains so that it is blended with many other deposits. An original bed on a hillside may finally join a sedimentary deposit many miles away for its final resting place.

Sedimentary Clay. As has just been mentioned, residual clay very often does not remain in the place of its formation, but is carried away by the action of water. Floated along during periods of high water, it finally is deposited as a sediment in the bottom of quiet pools or angles of slow streams. Usually these deposits lie in layers, with the coarser sand toward the bottom. If the entire watershed of a particular region was formed of one type of rock, the sedimentary clay of that locality will show only slight variations in content. As a rule, the clay in any region is rarely without considerable differences due to the variety in the rock formations in the area drained.

Clay for the Potter's Use. For pottery, clay from either the residual or sedimentary formation may easily be found, though the most common finds will probably be sedimentary banks. For the much fewer deposits of pure feldspathic clay, known as "kaolin," a wider search will have to be made, and the worker must not be disappointed if he is not able to locate a deposit of such a nature. An analysis of kaolin will show it to be composed largely of silica, alumina, and water, with a very

Fig. 5. The results of firing a clay that is too fusible.

small percentage of other minerals. It can be seen then, with the very nature of soil in general, a pure deposit would not be easily found.

Some authorities have stated that the best grades of kaolin can be found only in Europe and not in America, because the latter continent is not old enough geologically. Whatever the facts may be, it is rather interesting to note that some of the finest porcelain in the world now is made in America.

Kaolin is of residual formation and is the result of the decomposition of feldspathic rock. It stands a very high temperature and has a white or creamy white appearance. For the student of art pottery, kaolin will probably play its most important role in the field of glazes of which it is a necessary part.

Classification of a Few Common Clays. Besides kaolin, a few other types of clay will be mentioned here, as they play a more or less important part in the industry as a whole, and bring home the fact of how widely dependent the human race is upon clay.

Fire Clay. A highly refractory clay used for firebrick, furnace linings, etc. It consists of small portions of iron, lime, or alkalies, and a great deal of silica.

Pot Clay. A fire clay used in the making of melting pots for glass-work. It is strongly refractory.

Retort Clay. A refractory clay used in the building of retorts, which are vessels made of fire clay used in the making of coal gas.

Pipe Clay. A grayish-white clay, extremely plastic and quite pure, used in the manufacture of sewer pipes, in printing calico, etc.

Sagger Clay. A refractory clay used in the manufacture of saggers which are boxes made of fire clay in which fragile pieces are placed while being fired.

Ball Clay. A white burning pipe clay quite plastic, used in some glazes, porcelain, stoneware, and the like, where its plasticity is needed.

Paper Clay. An unburned clay used in the paper industry. This again is a plastic clay and is mixed with the paper pulp.

Portland Cement Clay. A clay used in the manufacture of Portland cement. It should be free from lumps of sand and gravel.

Mineral Clays. Some clays are used in the paint industry to give color and make a cheap product.

Slip Clay. A very soft fusing clay used as a glaze on some clay products. Probably the most satisfactory is found at Albany, New York.

Fig. 6. Laying in the winter supply of clay.

Other Clays. Then there are clays used in the manufacture of drain-tile, high-powered insulators, roofing tile, hollow tile, spark plugs, crucibles, and many other lines which cannot be touched upon in these pages.

Prospecting for Clay. The presence of a clay bed usually may be detected through an outcropping in some ravine or bank. These exposures are commonly found on steeply inclined surfaces, in railroad cuts or along graded wagon roads. Oftentimes, springs issuing from the same level along a hill or slope offer a good opportunity to find clay. Many times the desired material is found while digging ditches, fence-post holes, or wells.

Several beds, if possible, should be located so as to obtain a clay which will produce the best results. When once found, several problems must be considered. Before removing a large amount of clay, samples should be taken and tested thoroughly as to firing, shrinkage, color, fusibility, warpage, glazing, and so on. Methods of manufacture also must be considered, as some clays are much better than others for a given purpose. If these problems have been solved and the clay has been found adaptable to various needs, the right to remove it must be obtained, and the method of transportation considered.

Some clays are more suitable for use on the potter's wheel, while others are better for casting. As a rule, the more plastic, adhesive clays are better adapted to casting than the short, lean ones, while a medium

grade of plasticity is better for handwork and for throwing on the wheel. To make tile, a somewhat coarser grade should be used or grog added to the plastic supply.

Some clays will stand firing in larger, heavier pieces, without breaking, better than others, and are good for work where pressing into heavy forms is demanded. A clay can be of a fine texture and still be inclined to warp, while another will have a tendency to crack or break. Again, the fusing point may be too near the temperature of the glaze to be used, so that there is danger of loss by melting and warping. It is well always to be on the alert for a good bed of clay, as any clay in use may be improved on in many ways. The ideal clay bed probably never will be found, but in different beds several kinds of clay may be discovered, which may be adjusted to use for various products.

Short clays can be mixed with fat clays; refractory with nonrefractory; and fine clays can be balanced with coarse. A fine point is reached when the clay, when fired, is vitrified just enough to give the ware an excellent grade of hardness without danger of warping in the glost fire. A too highly refractory clay does not give a tough and hardy dish, and such a dish may be much more inclined to leak after it has been glazed. A well-fired piece of pottery will have a clear bell-like ring when tapped with a pencil.

Accessibility is also a problem of importance, especially if the clay is to be used in any quantity. A good trail or road is a necessity, and many times is the deciding factor in the cost and sales price of the product. The writer at one time undertook to sell clay for a friend. It was a most excellent pottery casting clay, but the bed was far back in the mountains. The location made the sale a failure because the cost of hauling and handling was far above the best price offered.

If the clay is for schoolwork, the more nearly free it is from foreign substances, the better, as the teacher will probably have little time for thorough washing and screening. Clean beds of clay can be found where a deep cut has been made for a highway or railroad. In such cuts it is sometimes remarkable how absolutely free from roots, gravel, or rocks the clay can be dug.

It is well to gather a large enough supply to fill the needs for a considerable length of time, as clay should be well dried and stored in bins before it is used. Wet clay is practically insoluble in water, while dry clay will go into solution in a very short time.

Preparation of the Clay. For the small shop, school, or camp, two or three large, hardwood barrels are needed. Old vinegar or liquor barrels, purchased at $1 or $2, will do very well. Into one of these, place a quantity of dry clay well broken up. Cover this with clean water and allow it to stand overnight. From the nearest supply house, get a piece of copper lawn of about 40 mesh and 18 in. square. With some good lumber, build a box about 6 in. deep and large enough to use the copper lawn for a bottom. Fasten the lawn on the box with copper nails and strips of copper so that there will be no danger of the screen coming off. With this good homemade screen, and another barrel, clay can be screened in moderate quantities for any desired purpose.

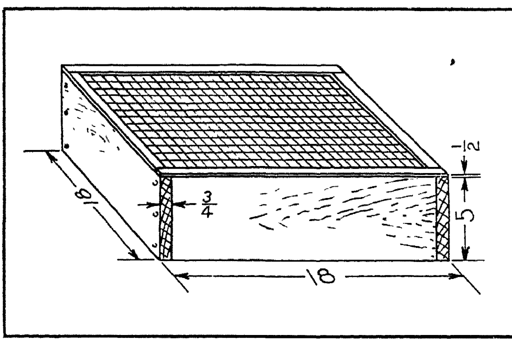


Fig 7 A slip screen may be made by fastening a 40-mesh copper lawn on a wooden frame with ½-in. copper strips

Screening Clay. The screening of clay for a school or small shop is a muddy, though not difficult job. If one is not in a hurry and has plenty of water in a convenient place, it is easier to screen a thin solution of clay and water than a thick one, waiting for the mass to settle and thicken. However, if slip is needed immediately, it will be found possible to screen the clay when it is quite thick, and thus produce a mass practically ready for use. Having decided on the kind of clay to be used, the clay and water, after standing together for six or eight hours, should be thoroughly stirred in the barrel until well mixed. This mixture of unscreened clay and water is known as slurry, and after it is screened is called slip. Its density will, as has been mentioned previously, depend upon the length of time it has been standing. As

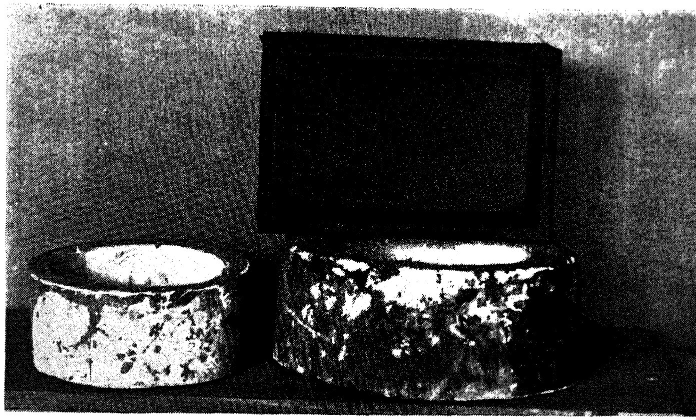


Fig. 8. A slip screen and plaster bowls.

slip improves with age, it is well to prepare a quantity for future use. In such a case, the mass of slurry should be just thick enough to run easily through the screen. A barrel or two should be screened full of this thin liquid and allowed to stand, dipping or siphoning off the surplus water until the liquid clay is somewhat like a thin cake batter. This can now be covered and left to stand until ready for use, though one should not forget to stir it occasionally to keep the bottom from growing thick and lumpy. If two kinds of clay are to be used in making up the slip, it is well to soak them in separate barrels and then mix by screening instead of putting the two together in one container. Some kinds of clay will separate when screened at one time and thus a definite mixture is not obtained.

Modeling Clay. If the clay is not intended for casting, but rather for modeling, the settling should be allowed to go on until there is left a thick mass, which can be dipped out and placed in plaster forms to stiffen (for plaster forms, see Ch. VI on Plaster of Paris). When the clay has reached a good modeling state, it is ready to be packed away until such a time as it is needed.

Storage Bins. A convenient container for storing wet clay can be made from a strong box fitted with a tight cover. The bottom of this box must be coated with a thick layer of plaster of Paris. The plaster, when soaked, will give off moisture and keep the clay in excellent shape for a long period. If the expense is not too great, it is still better to line

the walls of the box with zinc so that the moisture will not warp the wood.

The prepared slip can be left in one of the barrels and will keep indefinitely, provided it is not allowed to become dry by evaporation. It improves greatly with age, but it is well to keep the batch thoroughly stirred from time to time as lumps will form which spoil many good castings.

Prepared Bodies or Pastes. The discussion thus far has dealt with work for simple bodies in which the natural clay can be used. If more ambitious lines of production are to be undertaken, in which stoneware and semiporcelain are made, then the problem of preparing the mass according to definite formulas must be considered (see Ch. XX).

CHAPTER III

Hand-Built Pieces

FOR the beginner, delving into the mysteries of pottery for the first time, it will probably be well to follow the primitive method and shape the first pieces by hand, even though the results will be crude. Skill will come through practice, and eventually some very fine pieces can be made. However, from a remunerative viewpoint, this hand method is entirely too slow, but it can be considered as an easy introduction to the many processes to be learned in the making of pottery.

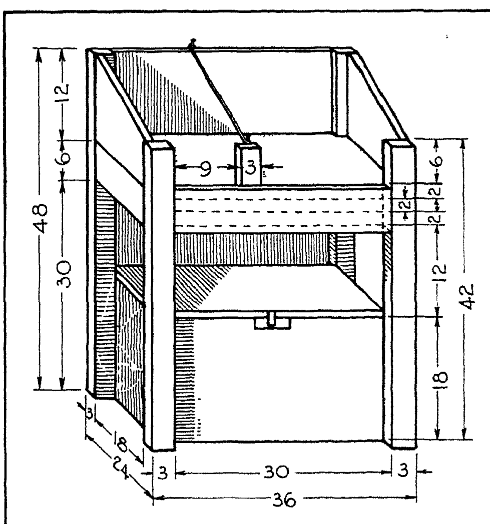


Fig. 11. This individual wedging table is a good size for a small shop; a larger one is shown in the chapter on Equipment. The lower section of the bed is made of 2-in. planking; the middle section, concrete, and the top section, plaster of Paris. The box under the table has a plaster bottom, and is intended for the storage of moist clay.

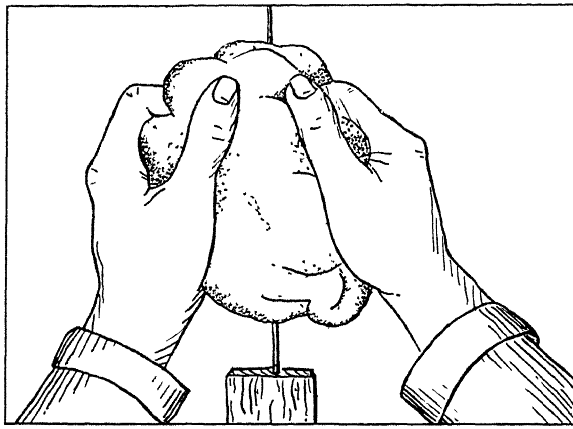


FIG. 12 To wedge the clay, grip it between both hands, cut it on the wire, and throw it forcibly upon the top of the wedging table.

Preparing the Clay. From a supply of screened and stiffened clay, obtain a lump about the size of a loaf of bread. To perform the first operation, take the clay to the wedging table, and cut it on a wire fastened from the top of a block of wood on the front of the table to the top edge of the back. Then throw the clay forcibly down upon the wedging plaster. Continue to cut and throw this clay until it is a smooth and uniform mass. If some of the lumps do not come out during this process, a beater can be brought into play, and the harder parts can be forced to yield to the treatment. The beater is a simple tool very much like a large old-fashioned potato masher, and it is used in about the same manner. The clay must be comparatively soft, yet must not be so moist that it will stick badly to the hands.

The Process of Building. When the clay has been thoroughly prepared, take a plaster bat, which is a flat slab of plaster, and soak it with clean water to the point of saturation. With this bat, the lump of wedged clay, and a convenient place on a smooth bench or table, you are now ready to form your first piece.

From the chapter on Patterns and Designs (Ch. IV), select a simple shape, not too large, and cut a full-sized pattern. It is well to select a design for a rather straight-sided piece, as pieces of this type are the least difficult to build. Cut a circular pattern for the bottom, and a contour pattern for the side so as to have a guide for accurate work.

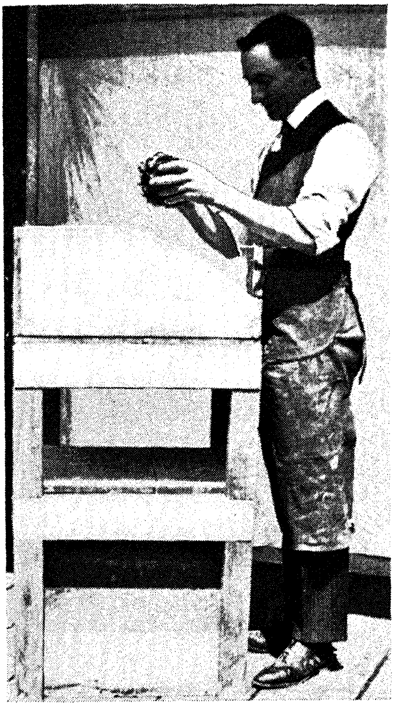


Fig. 13. A homecraftsman preparing his clay.

Three methods may be used in building pieces by hand. One method is by coils, another by pinches or small masses of clay, and a third by rolled and cut strips. The coil system is the most commonly used, and is usually the simplest. However, you must be extremely careful to rub the coils into a perfect union with each other, otherwise cracks will appear as the piece dries, and render it useless for firing.

The pinch method also has its problems, as it is much more difficult to build and keep smooth, uniform walls of an even height and thickness. It is worth trying, however, since with this method there is no possibility of developing cracks as in the coil method. Here, small pinches of clay are

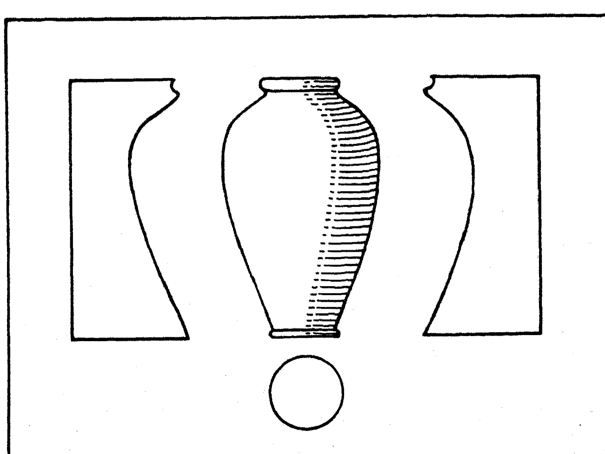


Fig. 14. Suggested design and patterns for the first hand-built piece.

used instead of coils or strips. A combination of these two processes has been found very satisfactory, using the pinch method in forming the bottom and occasionally in reinforcing weak places in the sides of a dish. Experience has proved that beginners have the most satisfactory results with this process. However, the newer and more interesting process is the strip method.

Coil Building. To make a coil, take a piece of clay the size of a hen's egg and roll it gently upon the surface of the table. Press down just hard enough to make the mass turn easily but not enough to

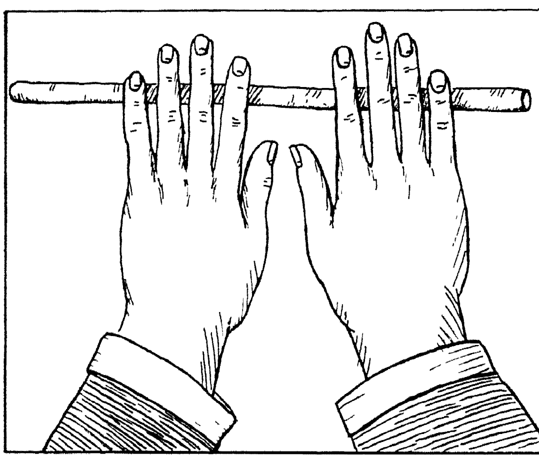


Fig. 15. The coil is made by rolling out the clay with a light, even touch. Heavy pressure will flatten it The best results are obtained with a decided outward movement of the hands while rolling

flatten it. Use both hands and start from the middle, depending upon an outward stretching motion rather than downward pressure, to make an even coil. When starting, the thumbs and index fingers of both hands should touch, but as the piece turns, the hands should rapidly separate with the actual outward pull of the clay.

Excess downward pressure, beyond merely enough to make the clay turn well, will produce a flat, undesirable coil, unsatisfactory in every way for use. Practice making a number of coils before starting on the first piece so as to become efficient in the process.

It should be easy to roll a perfect coil, ½ in. thick and 18 to 24 in.

long, rapidly and accurately. In fact, you will save time later if you master the few problems in this first process.

When several good coils have been rolled, use the plaster bat as a foundation, and on it coil the clay in a single, compact, and circular mass, forming the bottom of the dish. Place a few pinches of clay in any small defects which may appear in the center and at the end of the last coil. With a horizontal stroke, rub the surface of the coils smooth and even, taking off the upper segment of each coil and making of the whole a compact mass. When one side has been completed, turn the bottom over and finish the other in the same manner. Do all of this

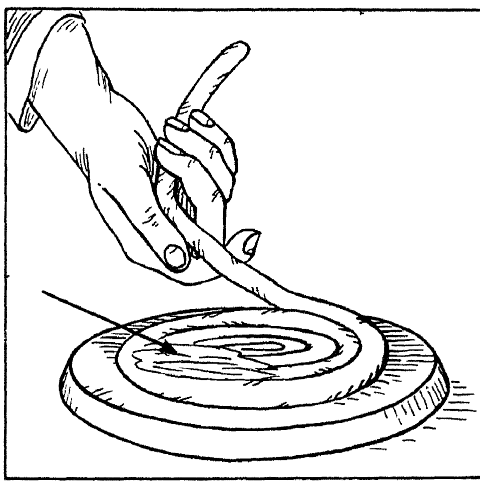


Fig. 16. The bottom is formed by tightly rolling several good coils together on a damp plaster slab. The arrow points to a spot where the coils have been rubbed together with a horizontal stroke.

work carefully, as the strain in drying and firing is very hard on the bottom of the dish. Use water sparingly in the process as there is danger of filling up the cracks with soft mud, which will crack in drying. Only after a piece has been completely finished with the hands and simple modeling tools, can a final finish with water be given advantageously. It is best to wipe the piece with a moist sponge when the dish grows too stiff for modeling.

When the bottom has been made as perfect as possible, begin to build

the sides. With the contour pattern at hand, lay a coil of clay on top and on the outer edge of the bottom piece. Have the coil reach completely around the bottom, and cut off the ends to form a neat joint. With the fingers of the left hand gently holding the clay on the inside, rub down the outer segment of the coil with the right hand, uniting it with the bottom of the dish. This governs the shape and should follow the outline of the pattern.

After the first coil has been placed and the outside of it joined with the bottom, take a small piece of wood or metal and rub around the inside to unite the coil very carefully with the bottom. Be extremely

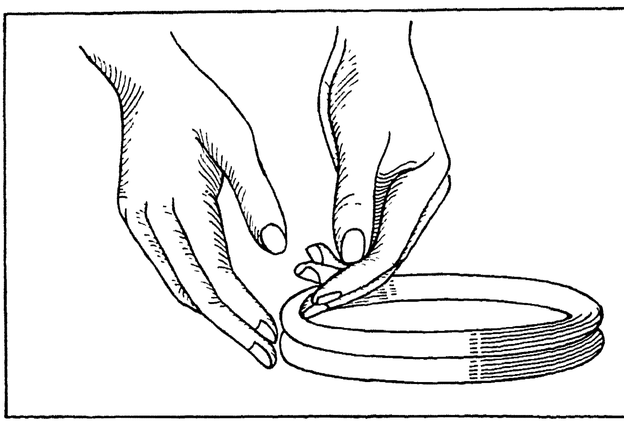


Fig. 17. After the bottom has been made to fit the pattern perfectly, the sides are formed as shown. A coil is fitted around the outer edge of the bottom, and the two are thoroughly united. The union is made on the outside first so as to preserve the shape of the piece. This first coil must be most carefully fastened to the bottom On the inside, it is well to take a modeling tool and force the clay back under the coil, then adding more clay to fill up any holes left by the process. The next coil or coils are then placed.

accurate in getting well back under the coil, and with extra pinches of clay fill up all possible places which may not have been united. All this may seem an unnecessary precaution, but bottoms have a way of cracking off and forming delightful covers.

After the first coil has been formed, the work proceeds much faster. Either of two methods now may be used. One is to place many coils one on top of the other until one fourth or one half of the piece has been made, after which the whole mass is rubbed together at one time.

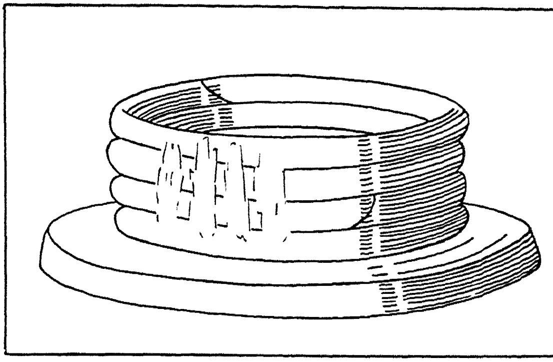


Fig. 18 Some prefer using more than one coil at a time in building up pieces of pottery, and this illustration shows the process. The rubbing is done vertically, the same as with one coil.

Speed is gained in this way but at sacrifice of accuracy in workmanship and form. The other method is to rub down each coil as it is placed on the work, and this, though a slower process, is perhaps the better one, in that fewer flaws escape the worker. In either case, the outside should be rubbed smooth first in order to control the shape, and then the inside should be finished. Whether one or more coils are used at a time, the rubbing consists of a vertical stroke up and down across the coils,

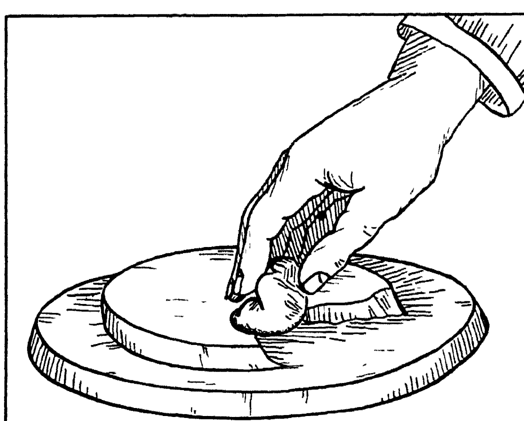


Fig 19. Because it is rather difficult to keep cracks from forming between the coils, some prefer to build with small pinches of clay. This illustration shows the bottom of a piece being built by this process.

taking off the outer edge of each and making the body perfectly smooth and about ⅜ in. thick. If the coils are well rolled, there should be little difficulty in keeping the walls of a uniform thickness and shape. If, however, small hollows and thin spots appear, rub in extra clay thoroughly so as to keep the walls of uniform thickness. Do not at any time depend on pinching to improve the shape as there is only danger of ruining the work in a practice of this kind.

After the piece has grown to a moderate size, the sides are likely to settle or sag. This sometimes occurs when the clay is soft and the pieces are large and heavy, or when the curve slopes away from the perpendicular. To remedy this condition, set the dish away in a moist cupboard for ten or twelve hours until the clay has had an opportunity to stiffen or set. This does not mean that the clay has dried out, but that a stiffening process has gone on which materially aids in the final shaping of the piece. (For information on the moist cupboard and the wedging table, see Ch. XX, Equipping a Pottery Shop.)

Finishing. When the bowl or vase has reached the stage where it seems impossible to do anything more with the hands to improve the detail or shape by modeling, set it away until the clay has had time to harden. This can be done in the ordinary air of the shop to the best advantage, though the drying cupboard can be used if the room temperature is not right. As soon as the clay has reached the leather-hard stage (that is, when it is comparable to leather), trim the piece with a knife or turn it on the potter's wheel like any thrown shape. Whether by hand or upon the wheel, attend to the top first, unless it is so accurate that nothing more needs to be done; then carve or turn the foot on the bottom so that the work will set well upon any surface. If the work is done on the wheel, the process is the same as that used in making any turning, but if it is done by hand, the methods are slightly different.

If done by hand, draw a line completely around the bottom of the piece and about ¼ in. in from the edge. With a small chisel-like tool of hardwood or steel, scrape the bottom down inside the line to a depth of nearly 1/16 in., keeping the tool at right angles to the work instead of trying to scoop the clay off the bottom. The scooping process is dangerous, since the tool may slip and pierce the bottom. Work to get a smooth, level bottom especially at the edge.

After all the turning or trimming has been completed, you can im-

prove the surface by a thorough rubbing with a moist sponge. If the piece is not to be glazed on the outside, polish it with any hard, smooth surface, such as a piece of glass or porcelain. This polished surface will not disappear even after the piece has been fired, but is no assurance that leaks will not appear.

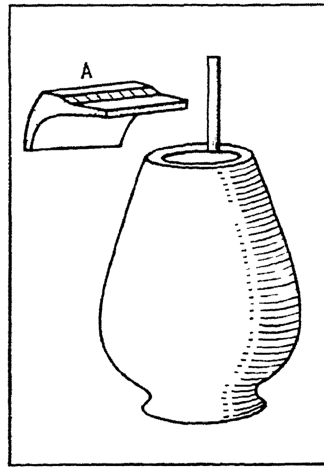


Fig. 20. The foot on a piece of pottery is made by marking off the size of the foot on the bottom, then scraping it with a sharp steel tool The scraping should be done at right angles to the piece, as a scooping stroke is likely to go through the bottom Section A shows an enlarged diagram of the foot.

The piece must now be thoroughly dried before any attempt is made at firing. The warming or drying cupboard becomes valuable here, as the process of drying can be greatly hastened with a mild, even heat. The temperature must not be high, however, and should be uniform over the entire surface of the piece. Drying more rapidly on one side than on the other will ruin the project as well as hours of good work.

Strip Method of Hand Building. Though the strip method of building pottery is not commonly used, it will prove well worth considering by the individual who wishes to produce pottery by a practical,

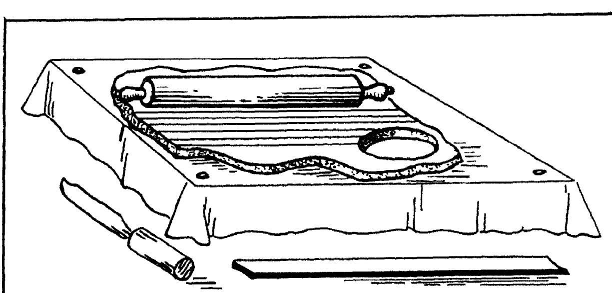


Fig. 21. The strip method of hand building is faster than the coil. A piece of cloth is fastened to a board, and the clay is spread with a rolling pin. The bottom is cut out with the use of a pattern, and the strips are cut with a straightedge as a guide.

efficient method. It is the most rapid hand-building process, and the one most likely to be free from defect, due to the fact that the process offers square surfaces to build upon instead of round ones.

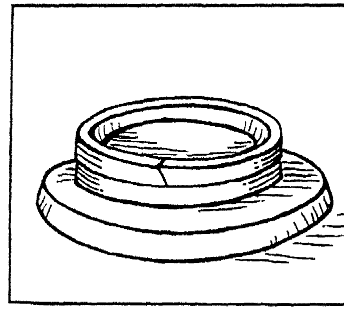


Fig. 22. Forming sides by the strip method.

With a mass of well-wedged clay, a rolling pin, a cloth, a knife, and a straightedge, you are ready to begin work. Lay a lump of clay upon the cloth and roll out a flat sheet about ½ in. thick and as large as the clay will permit. Place a pattern of the base on one corner of the sheet, and cut it out with a knife. Lay this bottom on a damp plaster bat, and then cut long strips from the sheet nearly 1 in. wide, using the straightedge as a guide. Lay the strips edgewise upon the bottom in place of the customary coils. The square, flat edge forms a very satisfactory surface to build upon and makes the process desirable where accuracy is of considerable importance. The remaining part of the work is carried on in the same manner as in the coil method.

Fig. 23. Average hand-built pieces finished with a matt glaze

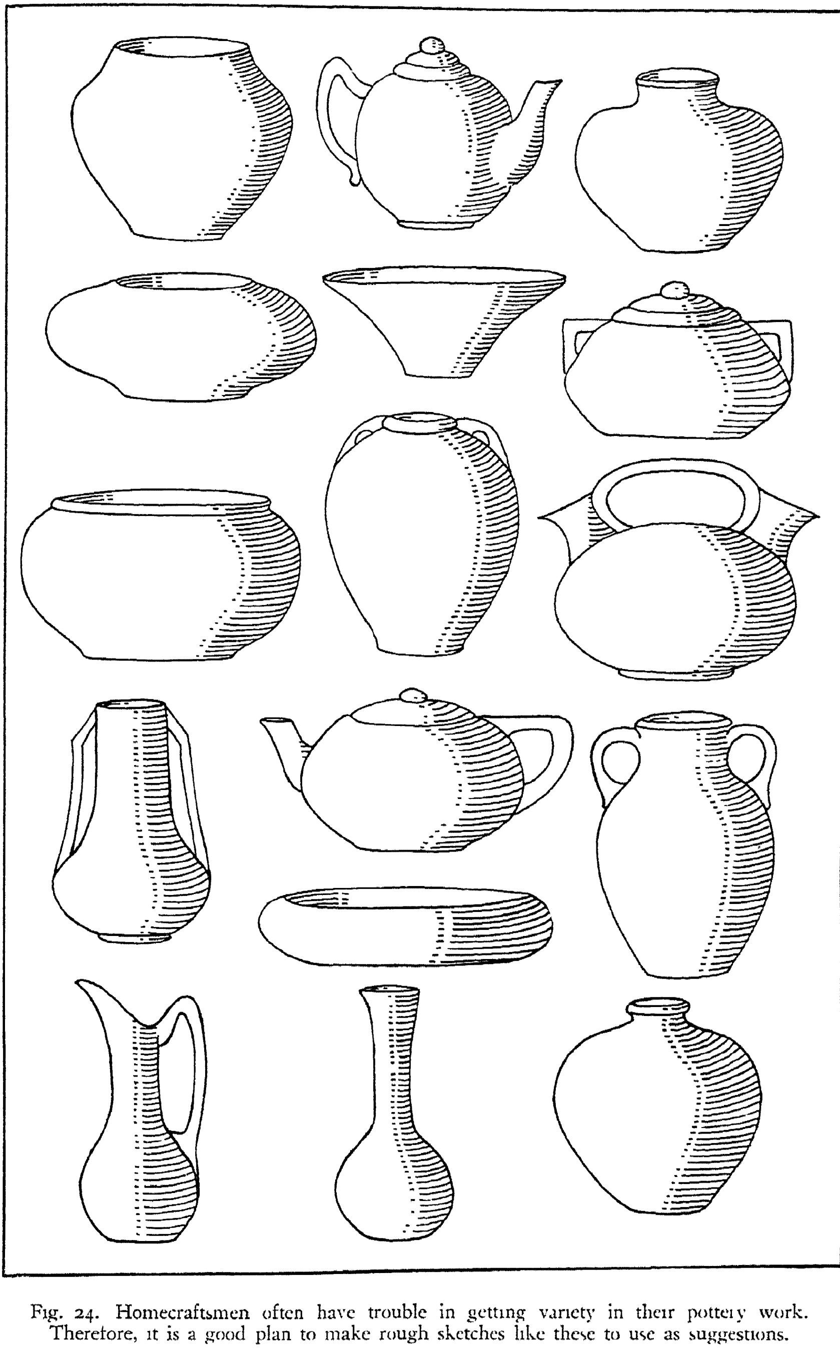


Fig. 24. Homecraftsmen often have trouble in getting variety in their pottery work. Therefore, it is a good plan to make rough sketches like these to use as suggestions.

CHAPTER IV

Suggested Pottery Designs and Decorations

THE production of desirable, artistic shapes and the designing of suitable surface decorations are essential problems which confront the maker of pottery. With the hope of assisting the beginner, this chapter has been written.

Form Analysis. By making accurate drawings of many of the shapes produced by the masters of the past, some interesting facts and conclusions may be drawn. When analyzed, Greek and Roman pieces have been found to be constructed according to definite geometric forms. The width of their pieces is so related to the height as to make a pleasing rectangle, while the diameter of the top is nearly the same as that of the bottom and is in direct line with it. A cylinder passed through these pieces would include the top and bottom, or, seen in cross section, would form another rectangle.

All narrow-necked shapes and pieces with small bases and wide tops come under the head of conic sections, that is, a cone with the point cut off. From a cross-sectional viewpoint, these cones are in the shape of triangles with the apex removed. The main rectangular outlines, too, are evidently based on the Greek law of subtle proportion with the "golden sector"—a 5-by-8 rectangle—as an ideal.

The greatest diameter of most pieces will be found either near the top or the bottom, but never in the exact middle or at any point which would spoil the general proportion or pleasing effect of the work. This fact is interestingly shown in the illustrations where the same contour is used with the top in the one case forming the bottom in the other. Their curves are all simple; the outline has little or no tendency toward the ornate, and the surfaces are not overloaded with masses of crude decoration.

In studying these shapes, a few simple rules can be laid down which

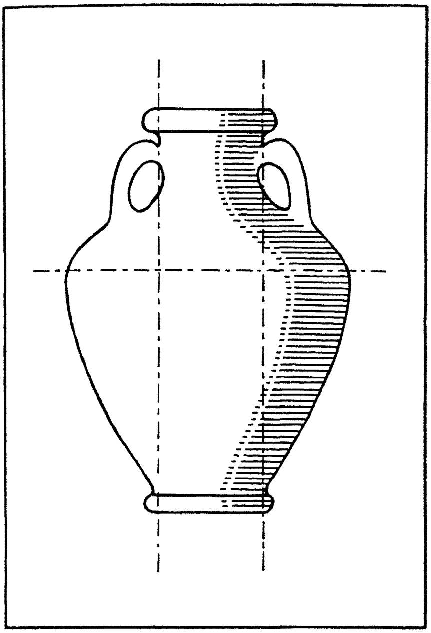


Fig. 27. This outline of an old Greek vase shows the relationship between the top and bottom of a piece of pottery, and the interesting placing of the greatest diameter. Note the vertical and horizontal divisions.

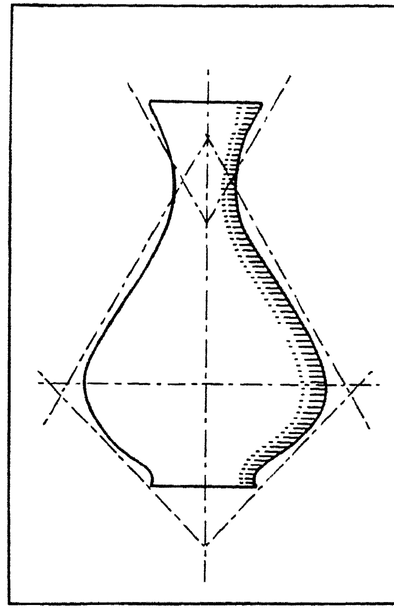


Fig. 28 Note the various triangles which form the basis for the construction of the vase, and yet there is still a definite relationship between the diameter of the top and bottom as in Figure 27

will aid in producing good pottery. For example, rectangular outlines are more pleasing than squares. The diameter of the top and bottom should have a definite relationship. The greatest diameter may be near the top or bottom, but should be so placed that it does not divide the whole form into halves, thirds, or fourths. Ornate outlines and elaborately decorated surfaces should be avoided. Pottery is not china and should retain a feeling of strength and virility. The curves of handles and spouts should be kept in harmony with the outline of the piece.

A few pages have been given over to illustrations taken from famous pieces, in order to give the beginner a suggestive line for thought and study. All of these have not been analyzed in the text, but can be understood by anyone who cares to carry on the study.

Design, or Surface Enrichment. In the field of surface ornamentation, there is also room for wide study. Due to the nature of the materials and the methods of application of the glaze, the more simple

types of design in relief or color upon the surface of the dish should be in rather large masses instead of fine, delicate lines.

Surface enrichment may greatly enhance the general appearance of a piece of pottery. It may be modeled in relief upon the surface, incised into the body of the work, or painted on it with slip. Whatever the method, if rightly used and placed, it will greatly improve the value of the piece.

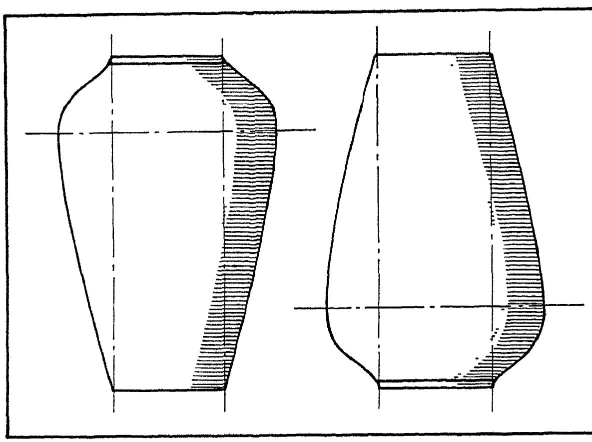


Fig. 29. The greatest diameter may be either near the top or the bottom, so long as the proportions are divided correctly in relation to the height.

Generally speaking, it is well to place the design upon or near the point of greatest interest on the piece of pottery. This point can be found by looking for the space where the eyes unconsciously fall when studying the object. If the point seems vague, the design will at times help to create this point of interest. This point may be a narrow space or a wide area, depending entirely on the piece, so that the design called for may be an over-all pattern or a narrow band around the edge. The design, as a rule, should be worked in while the clay is still moist. When the piece has been dried and fired, the design can be developed still further through the use of different colored glazes. This is particularly true where the design has been incised. The depressions thus made lend themselves particularly well to the application of the glaze, and the very fact that the work was cut into the piece, aids in holding a fluid glaze in place. With designs in relief, the ornamental motif is

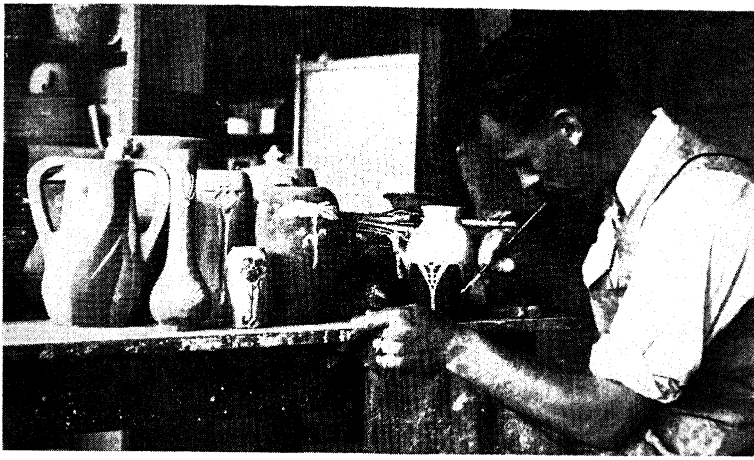


Fig. 30. Underglaze decorating is an interesting line of work. The colors are applied to the biscuit ware. The pieces then are covered with a clear glaze and refired.

considered to be sufficient through its method of placement, to be quite decorative, whether accentuated by the addition of color or not. In either case, where colors additional to that of the main mass are used, great care should be exercised to apply the glaze as evenly as possible.

Ornamental Glaze Application. Surface decoration, however, may be made in other ways than by modeling the damp clay, and these means offer a wide field for experiment to those individuals who are interested in this particular phase of the work.

Where matt glazes are used, a good deal of decorative design can be worked out by using the different colors and painting the glaze on the smooth surface of the biscuit piece. As these glazes do not run or correct any small defects, this method demands very careful work to get results.

Another type of glaze ornamentation, which is not difficult and yet has possibilities, is the combination of gloss glazes in blends and spills. This process is not difficult, but again demands good judgment and careful workmanship. The main background or body of the glaze is put on first, and contrasting glazes are applied over it. This combination may be obtained by having the overglaze put on as a spill carried out from the inside of the piece and flowing down from over the top much as a pot would boil over, or to blend the overglaze into the back-

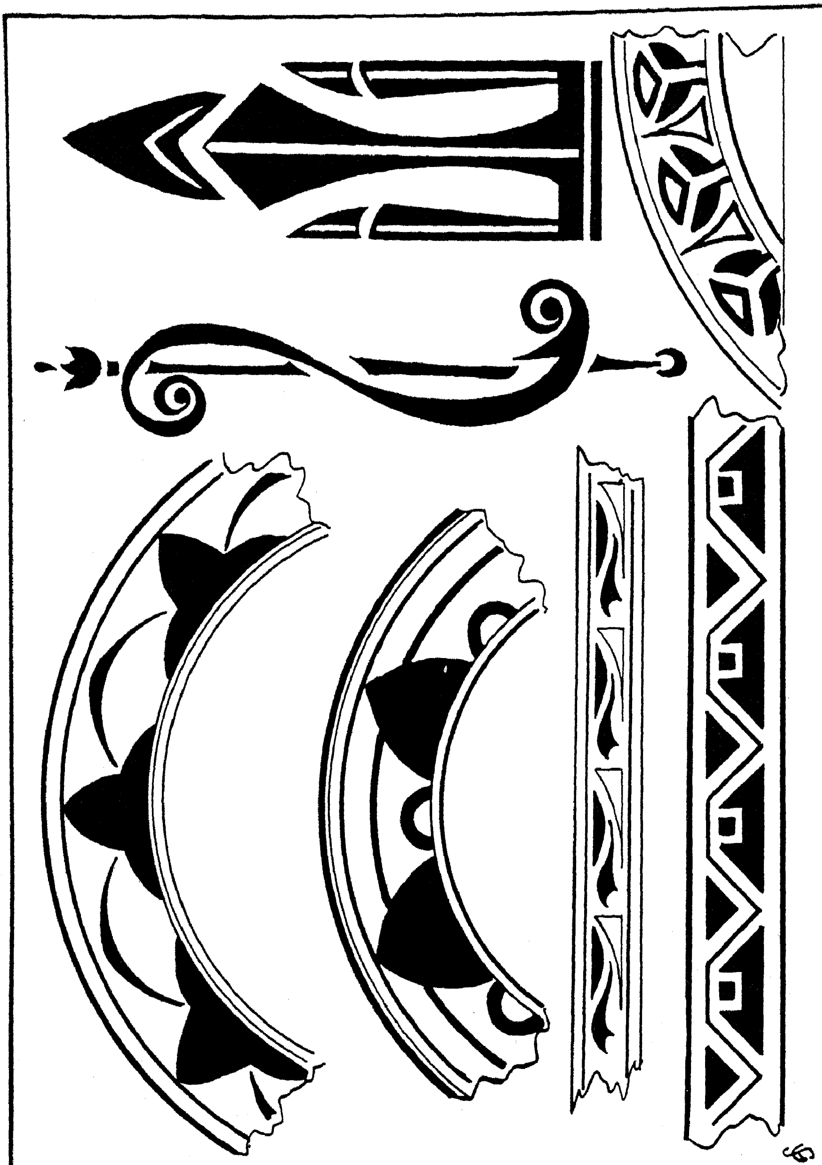


Fig. 31. A few decorative ornaments. The worker must keep in mind that the units of design must be rather large masses for pottery and not fine lines as in porcelain decoration. Designs of this nature can be modeled in relief or incised in the clay. The small design can be made in soft clay with a stick.

ground with thin, light coats brushed over the entire piece. This work can be carried on with matt as well as with gloss glazes; the blending is not so nearly complete, and the contrasts are more sharply drawn.

Matt glazes should not be used over gloss glazes as a spill or blend, and likewise, the gloss should not be applied to the matt, as the two types of glaze do not blend well when put together. If both glazes are to be used on the same piece, the surface to be covered should have the one glaze applied and that only, and then the other glaze should be brought up just so the two meet but do not overlap. By this method, a matt spill can be put on a piece with a gloss base or in just the reverse.

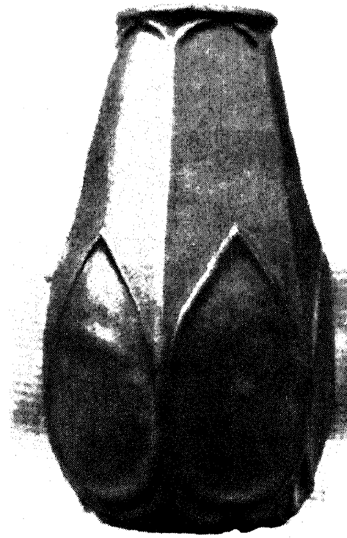


Fig. 32. Relief modeled on a hand-built piece.

For still further experiments in color variety and combination, two batches of glaze of different colors may be poured together in different proportions. This will give a variety of results depending upon the completeness of the blend, color combinations, and the like. If thoroughly mixed, a green-gray composition is most likely to result, especially where several colors are used.

Lusters. There are several types of lusters, and it is possible to prepare a number of them in the ordinary shop. However, the processes are so exacting that the average individual will be satisfied to purchase his material from a reliable house, leaving the fabrication of the mixture to the chemist.

When rightly applied, lusters can greatly enhance the beauty of a piece, but when poorly done, little, if any, beauty is gained by the process. For the average shop, the application of a luster will prove rather difficult owing to the necessity of absolute cleanliness which the work demands. Lusters are painted on the glazed surfaces of the fired dish. Modern lusters are combinations of metallic oxides and extremely delicate oils. The oils disappear under the influence of heat, leaving

the metal deposited upon the surface of the glaze. The temperature is a dull red (cones 016 to 018). The painting and low firing sound easy, but will prove rather difficult and make a decided demand upon the dexterity of the individual worker.

Under- and Overglaze Painting. In this field also there is room for wide work and study. Here, also, the student can prepare his own materials, though it is doubtful whether he will do as well as to buy from a reliable ceramic house. Unlike the preparation of a glaze, the quantity of chemicals used is so small, that, though the price is high, little can be saved by home production. In this work, as in the case of lusters, care, cleanliness, and accuracy make exacting demands. For those who desire seriously to study the subject, it would be well to augment their experience with the study of books devoted to the subject.

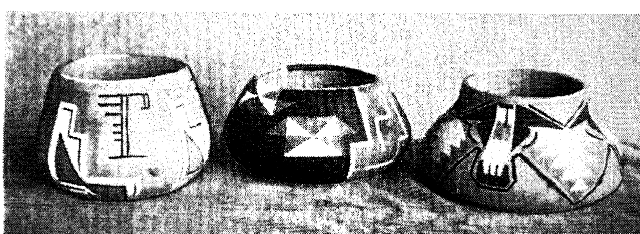


Fig. 33. Painting on unglazed pottery with ordinary dry pigments is interesting work. The biscuit-fired piece is first sized with ordinary mucilage. Colors then are applied with artists' brushes. More mucilage is used as a medium for the paint. When finished, the outside is polished with furniture wax and the inside is coated with hot paraffin to prevent leaking.

In another method, water colors or show-card colors can be used on the biscuit-fired piece without mucilage. If the furniture wax blurs the colors, spraying lacquer should be used.

CHAPTER V

Plaster of Paris and Mold Making

PLASTER **of Paris.** Plaster of Paris plays an important part in the production of many kinds of pottery, and in many other ways is a useful material. It is hemihydrate of calcium sulphate becoming a hydrated sulphate when mixed with water. Less technically speaking, plaster of Paris is obtained from gypsum rock by firing the stone in large kilns, until the latent moisture is largely driven off, after which the rock is ground to a fine, white powder.

Casting plaster is made from the same material and in the same manner except that it is ground finer, sets more quickly, and forms a finer, smoother working surface. It is to be recommended wherever one wishes to do a fine piece of work. If it is not obtainable, the regular plaster of Paris will do, or even some of the wall finishing plasters, though their speed of setting is so slow that it is quite a tedious matter.

When buying plaster, it is cheaper to make the purchase in 100-lb. lots, or, still better, in 1-ton quantities if the demand of the work will justify the purchase. If the climate is not too moist, plaster will keep for a long time, and can be stored until needed. However, care must be taken to see that the storeroom is thoroughly dry, as plaster of Paris will absorb moisture from the atmosphere and become valueless.

Using Plaster. For work in plaster of Paris, get a good-sized bucket, a pair of spring scales, several strips of linoleum, and two or three pieces of board cut into circles of various sizes; also a strong cord, a knife, some wedged clay, a bottle of vaseline, and soap sizing.

A good object for the first experiment in the use of plaster is a plaster bat. This is a circular slab of plaster upon which are set the moist clay pieces to keep them in condition while modeling. Bats should be made in several sizes in order to fit any kind of work. A good average size is a circle 7 in. in diameter and 1½ in. thick.

To make a bat, saw a circle of the desired size from a 1-in. board. Around it tie a piece of linoleum, letting it extend 1½ in. above the surface. With a little vaseline, rub a thin film of grease over the surface of the board and the linoleum where the plaster will touch. Be very sparing of the vaseline so as not to have a coating upon the surface of the plaster as the grease will spoil the efficiency of the bat. With some of the soft-wedged clay, stop up any small hole or cracks in the form which is now ready for the plaster.

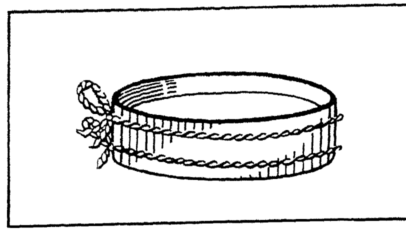


Fig 36. Instead of using the linoleum and board method, a shallow pan, such as an old frying pan, may be brought into service for making bats

Mixing the Plaster. There are many ways of mixing plaster of Paris for casting, and all, if rightly followed, are good, but for accurate and uniform work, it is most practical to carefully measure and weigh everything. Into a bucket, measure 1 qt. of water, or as many more quarts as are necessary to fill the form (1 qt. is enough in the present case). Into this water pour quickly from 2½ to 3 lb. of casting plaster which is the correct amount for the water used. When the water has penetrated the plaster, stir the mixture thoroughly with the hand, and fish out all lumps and stray particles that may be found. Now let the plaster stand, with only an occasional gentle stir, for 15 or 20 minutes, or until the mass begins to thicken appreciably. The thickening, which depends on the kind of plaster used, is an indication that setting or hardening is taking place, and that the mass must be poured immediately before it turns to rock. Pour the plaster in its now heavy, creamy state, into the waiting form, being careful to create as few bubbles as possible. When the form is full, jar it slightly to level off the surface, and then leave it to harden. In the meantime, wash out the bucket immediately and pour the residue into a convenient scrap barrel; not into the sink.

If the timing has been right, the plaster will set with a smooth, even surface, free from holes and defects. If poured too soon, the casting will have a coarse-grained effect, partly spoiling the efficiency of the piece. A slight shrinkage takes place at the time of the transition from the moist to the hardened state. If poured late, a defective mold is likely to result, or at best the surface will be hard and rough. Only

through practice will the right time of pouring be learned. On the other hand, when the plaster has started to set, it must be poured immediately and not left to stand. It will not do to keep on stirring in an effort to delay the setting, as the stirring will only make a soft, mushy plaster and spoil the casting. Care must be taken to fill every small crack in the form with clay, as the soft plaster has a way of running out, when least expected, and decorating the floor and the worker's shoes.

When the setting plaster has stood for some minutes, and has become hard, it will grow appreciably warm to the touch. This is an indication that the setting is complete and that the mold may be taken apart. The linoleum strip can now be removed, the rough edges of plaster scraped off, and the piece loosened from the board with a light jar. The plaster bat is now finished and should be laid aside for final hardening, while the worker goes on to the making of other molds or to the construction of as many more bats as may be needed in the shop. However, before going any further into the field of mold making, we shall briefly discuss sizes and sizing.

Size Making. In pottery work, size is a material used to keep one mass of plaster from permanently adhering to another mass, thus forming a solid block. A number of materials may be used for this purpose, such as shellac, vaseline, cup grease, oil, and so on. However, each of these materials has some fault when used in pottery making. In this work, the potter is dependent upon the porous nature of the rock to get the best results. If any substance is used in sizing which will stop or retard the suction process, the value of the mold is lost. In sizing it is, therefore, of importance to have a material which is in no way injurious to the suction action of the mold. This fact leads to the use of a common material, soap size, composed largely of a good grade of soft soap. Soap may leave a coating on the surface of a mold for a time, but the plaster will soon react on the soap and throw it off, leaving the mold in a fine, porous state. On the other hand, in using the soap sizing, great care must be taken to get a thorough coating, or a failure may be experienced in the parting of the blocks of plaster. A happy solution of a difficult problem can sometimes be made in using oil or grease wherever there is a spot in which the suction quality of the plaster is not needed.

To make a soap size, place a piece of Castile soap as large as an egg

in a quart of water, and heat on a stove until the soap is entirely dissolved. Then set it aside to cool. When cold, the size should have a body about the consistency of cream.

To use the soap size, apply coat after coat to the plaster until water will run off the surface as though the plaster were oiled.

Clay-Stiffening Forms. In pottery making, one of the articles needed almost immediately is a plaster bowl, or even several bowls, to stiffen clay for hand building and throwing. To make a bowl would be a very convenient practice problem in plaster.

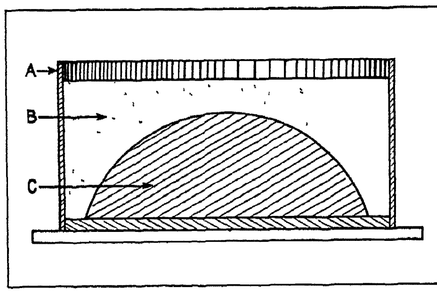


Fig. 37. A cross section of a casting for a clay-stiffening mold. A is the linoleum around a board; B, the plaster of Paris poured into place; C, the clay mound resting on a circular board

The method for making bowls will depend upon the intent of the individual potter and the permanency of the shop which he plans. If the work is for a short period only, then a temporary form will do, but if the potter's plans are to cover a definite number of years, that fact should be taken into consideration. For a temporary form, build a mound of clay in the center of a circular board, and turn this mound true on the potter's wheel. Make the mound the shape of the inside of an ordinary large mixing bowl. Leave enough space between the clay and the edge of the circular board to permit the forming of a heavy side wall to the bowl. Tie a strip of wide linoleum around the board, extending upward about two or three inches above the clay mound. Stop up all holes around the edge with plenty of clay. Now as described before, mix a good batch of plaster and fill the form. Sizing is not absolutely necessary on the clay, the linoleum, and board, though a little oil or vaseline will help in removing the plaster.

More Permanent Patterns. As has been mentioned, if the pottery work is to be of a permanent nature, then more lasting patterns for drying molds should be built. These forms may be made in several ways. (1) A simple way is by sizing and making a reverse mold from a newly made clay bowl. (2) Another way is by turning the shape from a casting of plaster. (3) It is possible to turn the pattern from a block of wood. Now any of the three methods will do, but the writer prefers

the last method, as a pattern made from wood will last indefinitely and stand a lot of abuse. These drying-bowl molds do not have to be exceptionally smooth, so that there is not the need of the extra smooth finish of plaster. Glue up some boards, then, into a solid block and turn a pattern on a lathe. Glue this wood pattern to the center of the circular board where originally the clay mound had been placed. Paint or shellac the surface so that the wood will be impervious to water, size with soap, and cast the mold as suggested for the clay form.

Vase Molds. No matter by what method of production the worker may intend to form his pattern, he will always find a few molds convenient for test purposes. Models for these molds can be made from several materials and in a variety of ways. For example, if care is taken, a nicely modeled dish, while still in the clay state and leather hard, can be used to produce a satisfactory mold. A vase of an attractive shape in almost any material offers another possibility, though the danger of breakage may discourage its use especially if the piece is an expensive one. A shape turned in wood, and well soaked in oil to prevent swelling, makes a good material for a mold. But the best, smoothest, and most satisfactory patterns are made from plaster of Paris. There are three methods of making these plaster patterns or models. The first, and probably the most satisfactory and accurate method, is to turn the pattern on a wood lathe. If a lathe is not accessible, the second choice is the potter's wheel. The third, and last method involves the use of a frame, with a piece of sheet iron for a template.

The Lathe Process. From Chapter IV on Design, choose a form which is entirely satisfactory, and cut a paper pattern the exact size of the piece including the shrinkage of the clay to be used. Cut out a circular piece of board a little larger than the greatest diameter of the shape chosen. At the center of this board nail lightly a piece of wood 1 in. square and a little longer than the entire length of the form to be turned. Around the center stick, wrap smoothly a layer of paper, pasting the edge to hold it in place. Now fasten a piece of linoleum around the edge of the board with a good wire or cord, having this stand up as high as the center stick. Tie the linoleum at the top as well as at the bottom, and close all of the holes with clay. Mix a good batch of plaster, and; after it has started to thicken, pour the form full, making a solid block around the central stick.

This board should be cut in the same general shape as the template so as to fit within 1 in. of the template's cutting edge.

On the head of the wheel, fit a circular piece of board as large as the vase to be made. With braces, fasten the template overhanging this board, barely clearing the surface and just far enough from the center of the wheel to allow for the diameter of the vase. Fasten the template so that the bottom of the vase will be on top. With a batch of plaster,

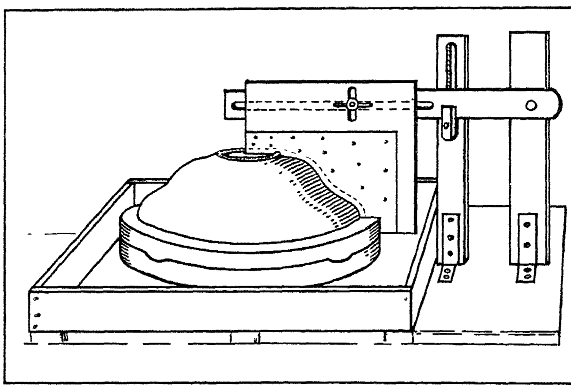


Fig. 41. When a lathe is not accessible, a potter's wheel may be brought into use. A metal template is cut out the desired size and fastened in place on a movable arm. A moist plaster is piled on the revolving wheel and a solid pattern of plaster is formed. This wheel also may be used later for making plates

just beginning to thicken, begin making a pile in the center of the wheel, at the same time keeping the machine slowly turning. As the template begins to scrape off surplus plaster, keep the metal edge well cleaned and free from lumps. Do not mix large quantities of plaster at a time but keep remixing until the mass as a whole has turned into the desired vase. The most difficult part of the process is to keep particles from forming rough edges on the template and scratching the pattern. When the surface has been made as smooth as possible, allow the piece to dry and then sandpaper it so as to get rid of all imperfections. Though this method is not nearly so satisfactory as the lathe process, it can be used where no lathe is available.

The Roller and Frame Process. Get a round piece of wood about 12 in. longer than the vase pattern to be made, and at least 1 in. in

diameter. Build a frame with ends 10 or 12 in. high, but with narrow side rails which will allow better access to the work. A strong box, with the sides mostly cut away, will do. At the middle of the ends, cut out curved places for bearings in which the roller is to rest. Fasten the roller in place with light strap iron. Make a template for the vase in the same manner as in the Potter's Wheel Process, and fasten this template parallel to the roller. Raise the back edge so as to bring this tool at right angles to the working surface when the plaster is applied. The roller now acts as a spindle upon which the plaster pattern is cut. This spindle should extend some 4 or 5 in. beyond the ends of the frame so that it

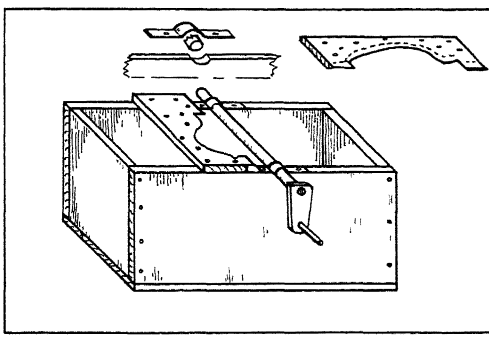


Fig. 42 Another method for making plaster patterns is by the box process. A spindle is fastened to the box with tin bearings, and a template is nailed the desired distance from it The plaster is gradually piled upon the stick This process is slower than the wheel as the layers of plaster must set upon the stick to keep the plaster in place

may be gripped with the hands while turning the pattern. When the process is finally finished, the spindle is driven out and the hole is filled. It is better not to make a handle for the short time the roller is to be used. If the plaster is inclined to stick too tightly to the spindle, a layer of paper can be pasted in place before the work begins. Mix small batches of plaster and let the process of setting get well along before trying to fasten it in place. Press the plaster upon the stick, making a rough ball. Keep mixing and piling on plaster, at the same time slowly turning the stick toward the template. As soon as the plaster has reached a sufficient size, the template will begin to scrape the surface of the

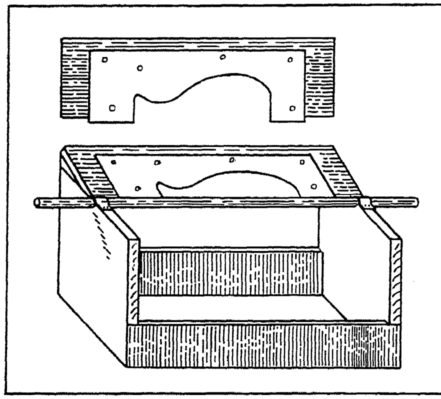


Fig. 43. The roller-and-frame method for making plaster patterns.

plaster to the shape desired. Toward the last, it is well to mix small quantities of plaster, and not try to finish the piece with one large batch. To get a good pattern, keep the template scraped clean of all lumps and bits of hard plaster that would in any way scratch the work. When making the template, be sure to carefully file all rough edges. Unless the template is perfectly smooth, scratches will show in an exaggerated degree on the surface of the plaster pattern.

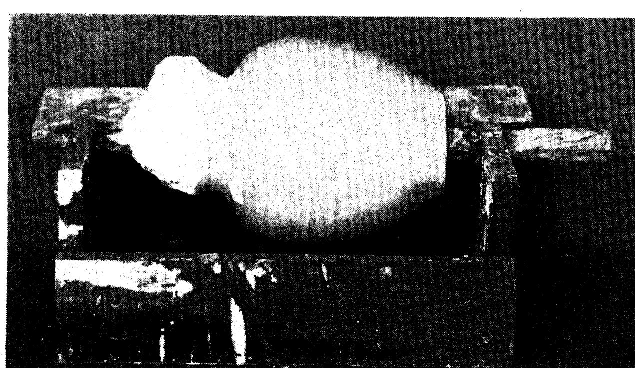


Fig. 44. A plaster pattern in the process of construction. This pattern is made by the box process. The construction of the box is shown in Fig. 42.

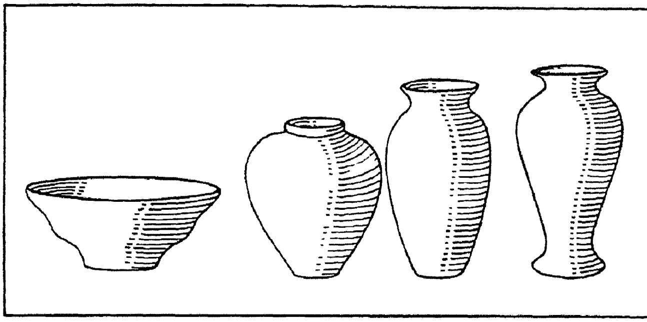


Fig 45 Progressive steps in mold making. The low bowl is a one-piece mold; the second form is a two-piece mold, and the last two are three-piece molds.

Making the Mold. When the pattern has been completed, the making of the mold is the next step. The question to be decided now is the type of mold best suited to the shape at hand. If the individual is new at the work, the first mold should be a rather simple shape with comparatively few difficult curves. A study of the illustrations in Figure 45 will show what is meant.

The very simplest mold is the one-piece type which can be used in the making of cups, bowls, flowerpots, and small vases. The chief requirement of the type is that the greatest diameter of the pattern must be at the very top edge so that the pattern and castings can be released from the mold. It can be readily seen that this type of mold is limited to a few forms of a definite shape and character, and even the cups and bowls can have little variety in their design.

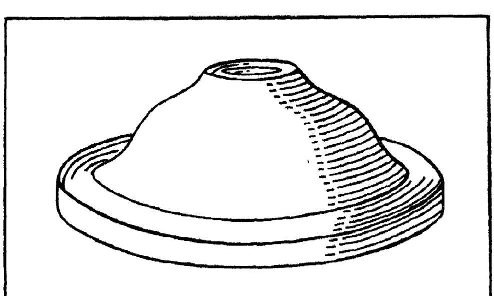


Fig. 46. The first pattern to be made on a potter's wheel.

The next, and one of the most practical forms of mold to be made, is the two-part mold. This kind of mold allows for many variations in form and the creation of many beautiful shapes with still a consideration for simplicity in mold making. The greatest diameter of the pattern may be anywhere between the top and bottom of the shape, which may be for either a vase or a bowl. The limiting factor in this type of mold is the necessary absence of reverse curves; that is, the parting line of the

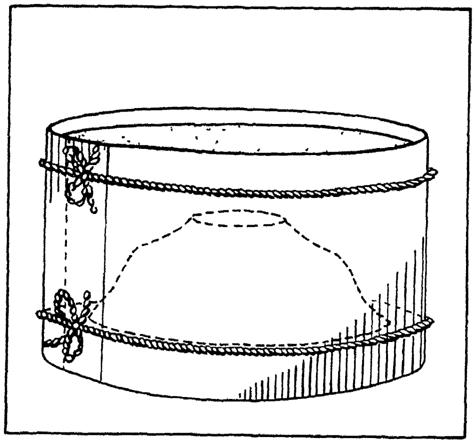


Fig. 47. In casting this first pattern, clay probably will have to be placed around the base of the linoleum to prevent the plaster from running out.

two halves of the form must be of such a shape as to release the halves of the mold when taken apart. It can be seen quite easily that there is a limit to the use of this type of mold, for immediately it excludes all extra curves at the top and bottom. It is, however, a very satisfactory form for beginners, as it is comparatively easy to make and almost a certain success.

The most general type of mold, from which any form can be taken, may be classified as a three-or-more-part mold. In the second group, the parting of the mold was always on a horizontal line and on the greatest diameter. In the three-part mold, the parting is on a vertical instead of horizontal plane, and as many parts as are necessary to get the complicated shape from the mold. Usually three parts are enough for a mold, though four parts at times make it much easier to separate. The

three parts would consist of the two halves of the main pattern separated on the exact middle up and down, and the bottom piece. Now if decorations are to be modeled on the shape, the vertical division will have to be made in such numbers as will best suit these designs. If the individual potter has the slightest doubt about the possible division of the object into two exact vertical halves, he had better make three sections of his mold instead of two, and avoid the difficulty experienced in taking the forms apart. It is an interesting study to examine the many complicated molds of the professional mold maker and to see how ingeniously problems are met.

After making the vase mold with a variety of curves, the beginner may undertake any problem. It should be remembered that practice is the best teacher. A few items, however, must never be forgotten, and yet

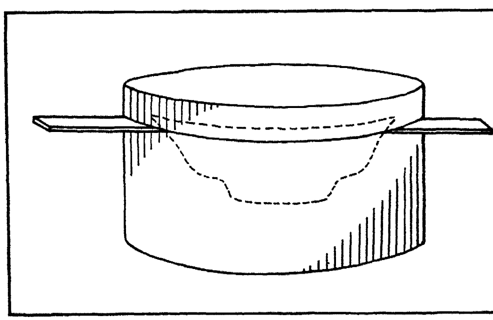


Fig. 48. Separating the first pattern from the mold

are quite often overlooked by the beginner. For example, the potter should never fail to size those surfaces well which must be parted. Do not rely on plaster not to run out of every small crack, for it will do so every time. Mix enough plaster at one time for the particular pouring at hand, if possible, and then do not pour until it has started to set. Do not try to slow up the setting process by stirring, as it will do no good and it will spoil the casting. The best time to separate plaster is shortly after the plaster has set and as soon as appreciable warmth can be felt with the hand.

One-Part Mold. The making of a one-part mold is such a simple process that it hardly seems necessary to devote any space to the methods involved. Briefly, the steps consist of sizing the pattern, placing around

it the retaining form, and mixing and pouring the plaster. In a two-part mold, the processes are slightly more complicated, and it may be well to consider the successive processes in detail.

Two-Part Mold. As stated earlier in the chapter, a two-part mold

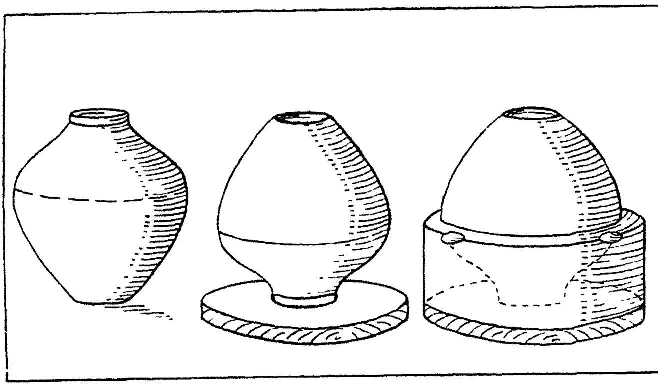


Fig. 49. In making the two-part mold, first a dividing line is made on the pattern which will allow it to be separated, and then the pattern is turned upside down on a circular board It is then buried in clay to the parting line, sized, and made ready for the linoleum

is very practical for many types of pottery, but it does have very definite limitations. Only a comparatively limited variety of shapes can be made this way, and hence care must be taken in choosing the pattern, to be sure that the type of mold is practical. Remember that all molds must be separated in order to take out the casting, and in a two-part mold there is only one line of parting and that is at the very highest point of the greatest diameter of the dish. From this point the top of the mold must pull up and off, and the bottom must pull down and off.

From the supply of turned forms, choose a desirable shape, and after having sized the surface, turn the pattern upside down on the center of a circular piece of board which should be cut about 4 in. larger than the greatest diameter of the shape to be made. Build a wall of clay around the pattern up to the greatest diameter (being sure that the sides of the wall of clay are true) to the edge of the circular board, and as far as the parting line. When through with the clay building, the results of the work should show a pattern, or form, buried to the parting line

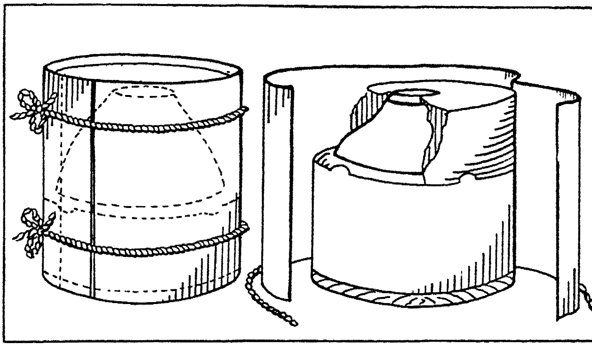


Fig. 50. The bottom half is poured, and the clay is removed from the second pattern.

in a mass of clay whose walls are smooth, perpendicular, and fitting perfectly the board on which the form rests. The edge, too, at the parting line, should come out clean and square to the vertical edge of the clay and should be accurate in every way. The circular board on which the pattern rests acts not only as a working surface for the clay, but also as an accurate guide to govern the thickness of the walls of the mold. The board also acts as a support for the linoleum which is next tied securely around it and the wall of clay. The linoleum must fit securely in every respect, and must extend well above the upper end of the form to such a height that, when the plaster has been poured,

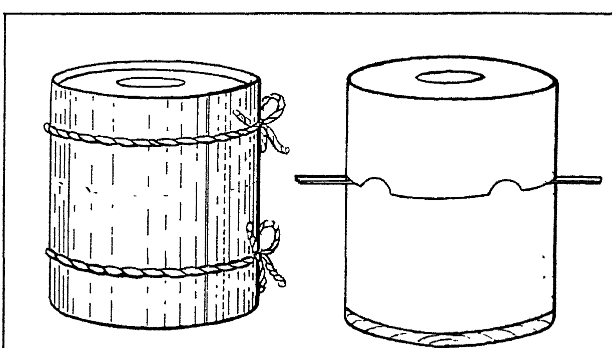


Fig. 51. The top half is poured and the mold is separated. In separating the sections of a mold, thin wedges of steel are good or a strong case knife will do. Great care should be taken not to damage the plaster mold or the pattern.

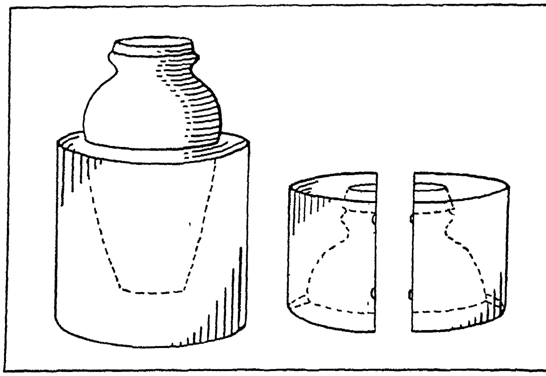


Fig. 52. One method of making a three-part mold This type of mold has the advantage of the parting line and the bottom of the mold not coming together which insures a better foot on the piece

the bottom of the pattern will have been buried in plaster at least 2 in. deep.

When the plaster has set hard enough to be handled, the linoleum and clay can be removed and the shape prepared for the second half of the mold. If there is any doubt about the pattern not coming easily from this bottom half, it may be well at this time to try to separate the two gently. The plaster now should be warm to the touch and a few gentle taps should easily separate the parts. In fact, they may even lift apart with no resistance at all. If the pieces stick together, some mistake

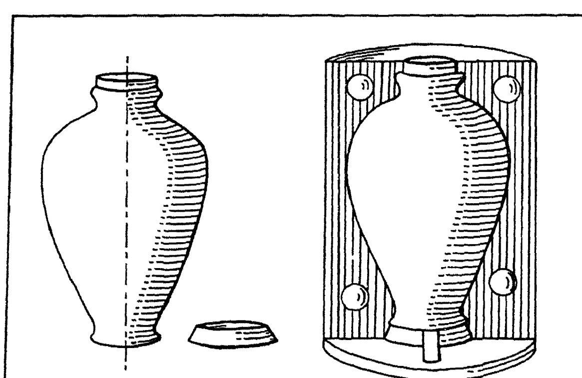


Fig. 53. The pattern of the fourth type of mold first is divided and then set on a block in the center of a circular board Then a parting wall of clay is built, the plaster is sized, and the linoleum is tied ready for pouring the first half.

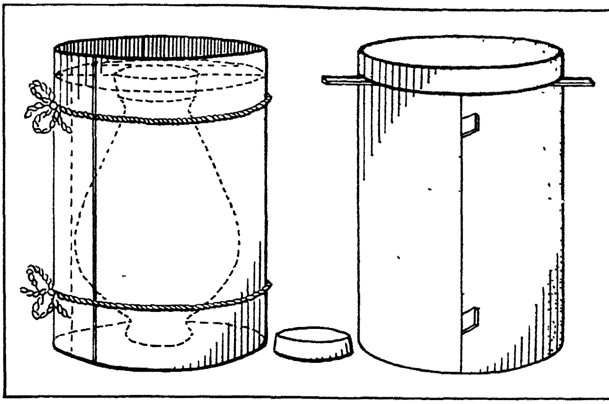


Fig. 54 Pouring the bottom and separating the fourth-type mold. In this type of mold one of the partings does come at the bottom. A little block thus is used so as to raise the footing of the vase away from the parting line.

has been made in the sizing or in the parting line and should be remedied before going further.

With the pattern fitting neatly in the bottom piece, clean off all rough edges and particles of plaster, cut two or three natches, or joggles, and size the new plaster. The form is now ready for the second half of the mold. The process is a simple one and consists of tying the linoleum once more around the piece and pouring the upper half. In this case,

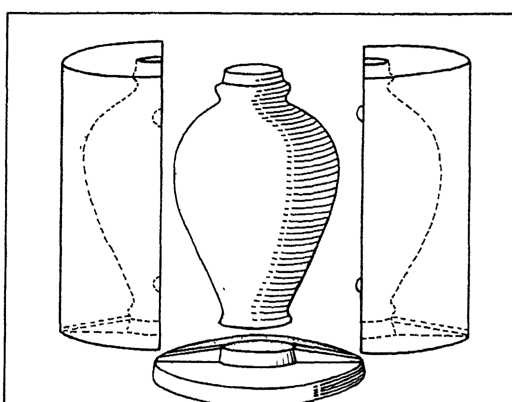


Fig. 55. The fourth-type mold separated. In this case is shown a practical type of joggle to hold the bottom in place. Remember that a joggle must be so constructed that the sections can be drawn away freely in casting. A section should be drawn straight out and not upward.

the plaster now should come only to the top of the pattern, leaving a smooth surface with the spare of the form showing in the center. As soon as the plaster of this second half has hardened, the linoleum may be removed, all surplus plaster scraped off, and, as the top cools, the mold separated with the blade of an old case knife or any other thin piece of steel.

Two of the terms used in the preceding paragraph may not be clear. One is "natches" or "joggles" and the other is "spare." When two pieces of a mold go together, there must be some definite means by which the individual may be sure that the pieces are placed exactly right so that there can be no slipping or ill-shaped casting. This is taken care of, by cutting notches or natches, in the plaster of one half so that the plaster of the other half when poured will fit into them. This insures the mold's going together in just one way and staying there when it is together. These cuts are called "natches" or "joggles."

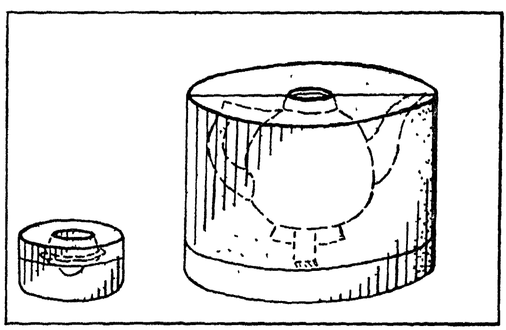


Fig. 56. A teapot with a handle and spout is hard to cast, but it is worth while trying. Before casting, plug up the spout part of the mold until the body is thick enough. Then remove the plug and cast the spout The cover mold is shown at the left.

The term "spare" should be familiar, as it was referred to earlier in the chapter when the topic of turning was under discussion. At the top of each dish, extra clay must be left for trimming. This extra clay is called the "spare," and can be seen at the top of any freshly cast piece of pottery. If this extra material were not applied, it would be very difficult to cast any pottery without damage to the top.

Other Types of Molds. After having successfully made one or two molds of the two-part type, little difficulty should be experienced in making the other kinds. Accuracy should, however, be the watchword all through every process in the work. The illustrations show several methods of reaching the same results. None of the methods are perfect, but all permit the potter to achieve good results when handled properly.

The Metropolitan Museum of Art
A Greek Athenian vase. This red-figured volute krater is of the early free style about 450 B.C.

CHAPTER VI

Casting

IN THE practice of the potter's art a great deal of satisfaction and pleasure are derived by the individual who is able to design and turn a project by hand. Many beginners, however, desire also to know other methods for making pottery, and for them this chapter has been written.

The potter's wheel is rather difficult to master, and it requires many months of patient effort to become skilled in its use. This fact causes a serious problem for the beginner who is anxious promptly to produce pieces by some method other than simple, primitive, hand building of forms. For such an individual, casting affords satisfactions which offset the disappointments of a lack of skill on the wheel.

Molds and castings, too, give the artist an ingenious method of saving work which otherwise might be lost in the first fire. The glost kiln has a habit of not respecting patient labor, and sometimes very fine pieces of work are forever lost because molds were not made.

In Chapter V, on Plaster of Paris and Mold Making, detailed steps have been given for the making of molds, and directions have been written for producing patterns for these molds. It was also mentioned that molds can be made from many other types of patterns, and that fact should be repeated here. Casting molds can be made from most of the hand-built work that is of a good enough quality to justify the trouble and expense. Well-modeled bowls, book ends, panels, low reliefs, clock stands, candlesticks, incense burners, paperweights, tiles, flower inserts, all can be made with the aid of some type of molds. Ingenuity, skill, and patience are the main requirements. Casting is a messy job, but the results fully justify any inconvenience which the worker undergoes. The pieces do not have to be fired first, and should not even be entirely dried, but are at their best when leather hard.

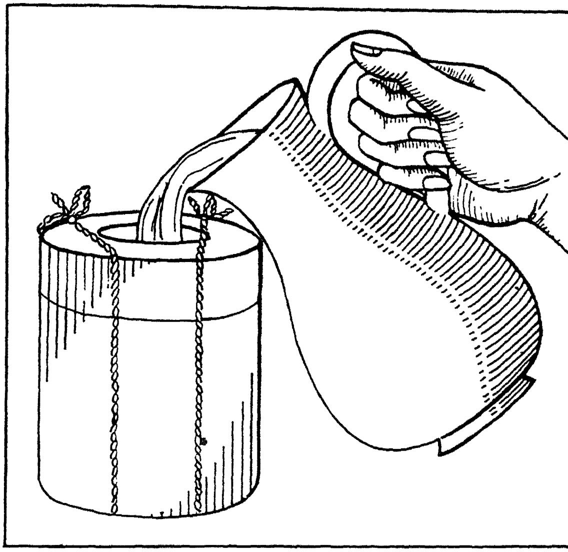


Fig. 59. When filling a two-piece mold, rubber bands may be used to advantage in place of strings to hold the mold together. If the mold is worn, clay will be needed on the parting line to prevent the slip from running out. Do the pouring with as few bubbles in the slip as possible Keep the mold full for twenty or thirty minutes and then empty it and set it aside for the casting to stiffen

The Slip. Before starting the work of casting, turn to Chapter II, on Clay, and read carefully the paragraph on the preparation of slip. If a quantity is already prepared, examine the mixture to see that it is the right thickness and free from lumps.

Check the molds, and use only those which are thoroughly dry. Tie the different sections securely, and with clay stop up any small cracks. With a good-sized enamel pitcher or bucket fill the molds rapidly with the liquid clay. Try to pour the slip as evenly as possible, avoiding any air bubbles that are most likely to be carried down into the slip on the sides of the molds. The casting is also a little nicer if the mold can be filled at one pouring, though this is not absolutely necessary. Where some slip is poured, and then more added to fill the mold, fine lines will afterward be seen on the sides of the cast piece. These lines will look like cracks, but are only results of different stages of filling.

The pitcher is mentioned first in the list of utensils for filling the molds, because the lip makes the pouring natural and easy. A bucket,

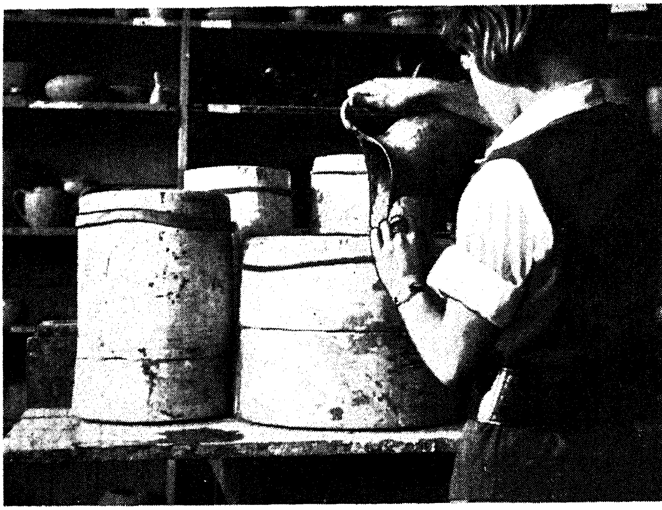


Fig. 60. Filling molds with liquid clay, or slip, pouring rapidly and evenly to avoid air bubbles.

however, is very handy where large quantities of slip are needed. In case the bucket has no lip, use a large spouted funnel. When the molds are once filled, it will soon be noticed that the slip has settled away. This is only natural, and shows that the molds are working; they must be kept full, so it is necessary to keep refilling them to the top. It is well to time the process of casting as it gives you a check on the thickness of the piece you are making. It is true that some slips cast faster than others, and also that various molds act differently. To be sure, one must watch the sides of the molds to estimate the thickness, and even then it is well to time the process. As a rule, small molds will work faster than larger ones, and thick bottom molds better than thin, but experience is the only guide. Some potters like thick, heavy pieces, and others prefer thin, light, almost frail ones. The personal tastes and needs of the individual must be considered while watching the slip do its work.

When the castings are thick enough, the molds must be emptied in order to make the ware hollow. This process is not difficult, except when the molds are large. The main problem is not to let some section of the mold slip and ruin the casting. Exercise care, also, to pour the clay smoothly from the mold so as to avoid spilling.

As soon as the mold has been emptied, trim off the surplus clay which

has collected around the top, and set the mold away for the clay to stiffen and shrink. While this stiffening is going on, turn the greater number of molds upside down. This permits the bottom to draw away from the mold and lessens the danger of cracking. With some molds, however, where the bottom is larger than the top, turning over cannot be done immediately, since the weight of the wet clay would cause the dish to collapse.

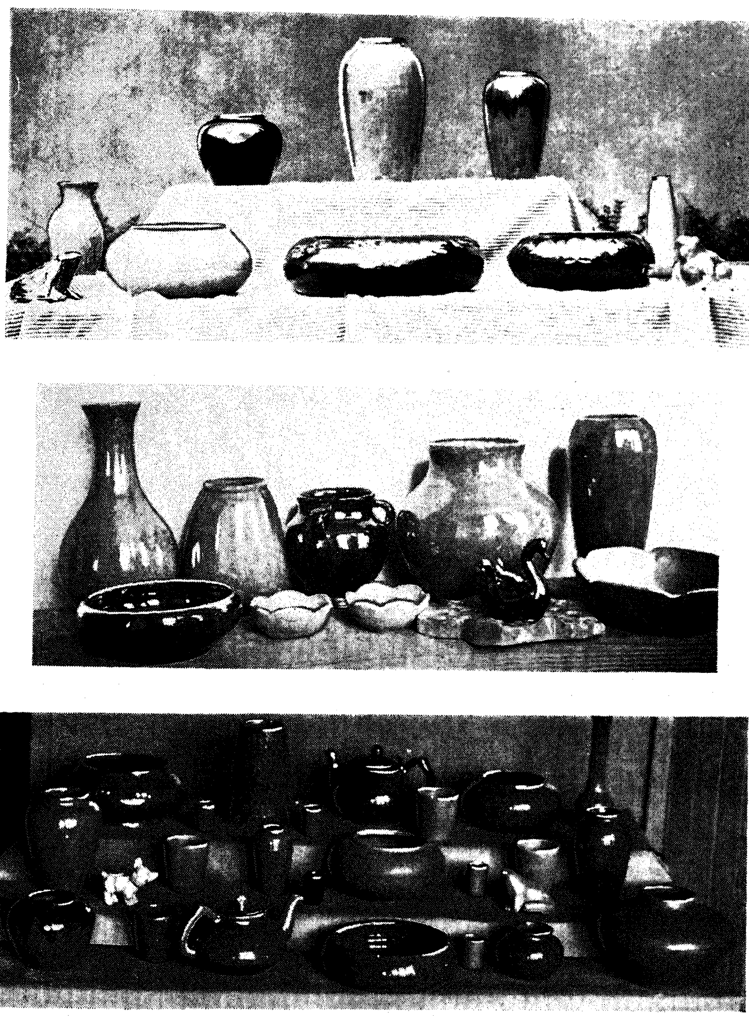


Fig. 61. Typical cast pieces.

Taking the Molds Apart. After several hours, loosen the cords that fasten the molds, and pry the sections slightly apart. Do this rather slowly and do not be in too big a hurry, as the soft forms can be easily sprung out of shape. As a rule, if the casting clay is a good mixture and does not crack easily, it is well to let the casting stand overnight and grow firm enough so that it can be easily handled. Little pieces can be rushed through more rapidly, but the very large ones must stay in the molds until the clay has thoroughly stiffened so as to insure the permanency of the piece. A large casting taken out too quickly will not hold its own weight.

Fig. 62. Turning the edge of a cast piece.

Trimming, Turning, and Sponging. As soon as the pieces have been taken from the molds, go over them with a knife and trim off the fringe of clay at the parting. Carefully fill all holes and small defects. Then set the pieces aside to stiffen to a leather-hard state, after which center them on the potter's wheel, turn off the spare material, and sponge the finished edge. As the pieces, now practically finished, are taken from the wheel, remove any minor irregularities with a damp sponge so that by the time the piece goes into the drying cupboard there remains little more to do.

Drying. Cast pieces of pottery can be forced to dry rather quickly if the heat is uniformly applied, but slow drying is safer, as a rule, and will result in fewer warped and twisted forms. As the pieces dry, the heat can be increased with safety and the process hastened in that manner. Drying successfully is a problem in itself.

Cover, Handles, and Spouts. Handles, covers, and spouts are easily separate problems, worthy of careful study. Covers involve considerations of suitable design and practical utility. Does the cover look well? And is it serviceable? These are two questions that must be answered. When casting a piece, the cover should be done at the same time, so as not to be overlooked, and must be finished and dried along with the body for which it is intended.

As a rule, handles cannot easily be cast when a piece is made, because, from the nature of the construction, the shrinking of the clay will pull the handles off or at least badly warp the piece. It is true there are exceptions to this rule, but usually the molds for handles must be made separately, and the handles must be pressed and stuck on after the body has been cast. If the clay has a high shrinkage coefficient, the problem will be increased, for the clay of the body and of the handle must shrink alike. Only dry handles can be put on dry bodies, but this demands perfect workmanship to insure a good fit, for only slip is used to stick handles in place. The slip must also be applied sparingly, as too much will result in failure. For the amateur, with ordinary clay, the safest method is to model the handle to the body when both masses of clay are of the same consistency. This demands patience and good judgment, but is an interesting experience.

Lips and spouts can be cast on with the main body, but in many cases they will be more satisfactory when made separately. A spout cast with the main body, unless it be a large spout, will be solid before the main body becomes thick enough. If a strainer is wanted, as in the case of a teapot, a one-piece casting would eliminate it. Spouts, as a rule, therefore, are more easily made separately, and are stuck or modeled on afterward. If cast with the piece, plug the spout up, for a time, with paper, while the main body is being formed, and then near the finish, remove the plug and cast the spout. This will keep the spout from casting solid, and make a good piece.

CHAPTER VII

Throwing

NO PROCESS of the pottery craft holds greater charm than that of throwing. It is, too, an exacting art and demands hours of patient labor for one to become its master. However, for anyone who loves to produce beautiful forms for the very love of form and beauty, no effort will return a greater reward than that of throwing. To take a mass of lifeless clay, and with the touch of trained fingers make it grow quickly into a form of grace and beauty is an art of which anyone may well be proud. And, though from a practical viewpoint throwing may soon become a lost art, it still holds great charm, and, in our busy rush of present-day mass production, with our many extravagant and oftentimes ugly shapes and designs, there is an open field for the true lover

RKO Pathe Dist. Corp. of San Francisco

Fig. 65. The Hindu has done his work in the same manner for ages, and is very skillful. Instead of making just one piece of the entire mass, he takes one pot after another from the top of his mound of clay.

of art to produce once more beautiful shapes with graceful lines and pleasing proportions just as our ancestors did long ago.

Throwing. Choose a lump of well-wedged clay about the size of an indoor baseball, and of a medium state of dampness. Clay which is very moist will be inclined to settle, while very stiff clay is difficult to handle and force into shape. Compress the ball of clay into a compact mass so that as many air pockets as possible may be eliminated.

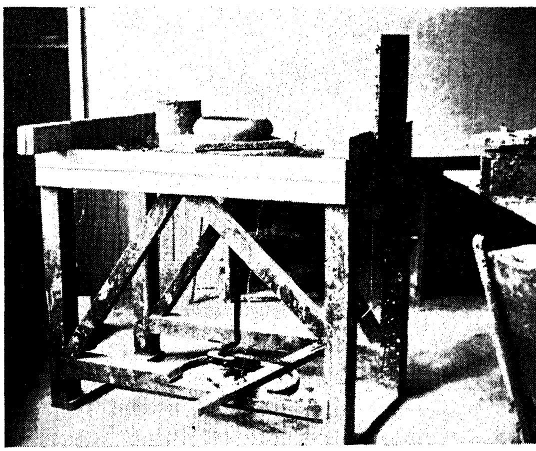


Fig. 66. In this type of wheel the worker stands and kicks with his right foot while leaning against the brace on the left side. If it is desired to kick with the left leg, the change can be easily made by placing the driving shaft to the other side.

The wheel should be in perfect readiness with all of the equipment in a convenient place. On it should be a can of warm water, a rib or two, a sticker, a soft sponge, a wire, and on the wheel head, a circular piece of board fastened with small pinches of clay. This last item may be used at the option of the worker, but makes a very convenient method of removing the first pieces without injury from handling. The skilled potter can deftly slip his piece from the wheel without injuring the shape, but the beginner will have problems enough without adding this one to his list.

Place yourself at the wheel, and for a few minutes practice running it until the process has become more or less natural. Turn the wheel from right to left, running it slowly, making about fifty or sixty revolutions per minute. When you feel that you have the wheel at your com-

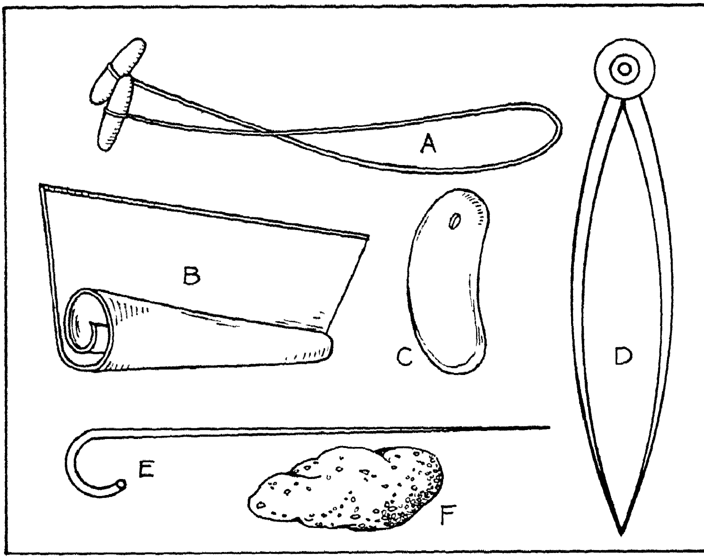


Fig. 67. Tools used in throwing. *A*, cutting-off wire; *B*, outside rib; *C*, inside rib; *D*, calipers; *E*, piercing tool; *F*, sponge.

mand, place the ball of clay in the center of the wheel head. If you wish, you may throw the clay upon the head quite forcibly, for it is probably this act which originally gave the work the name of throwing.

Centering. Moisten both hands well, and with the left, force the clay from the side of the wheel head toward the center, running the wheel slowly. With the right hand compress the clay on top so as to form a complete half dome in the center of the wheel head. This dome will not form perfectly with the first trial, but continued effort will be required to get results. Continue to push with the left hand, holding the arm rigid against the body, and at the same time slip the right hand over to the opposite side, pulling gently. This double action will aid in bringing the clay into the exact center of the wheel, and this must be the potter's first aim. Slip the right hand back over the top as you work so as to make the small half dome of clay perfectly smooth. Always keep the hands wet.

Drawing up and Compressing. With the hands resting opposite each other around the mound of clay, press in firmly and at the same time raise the hands. This should draw the clay upward into a cylinder and force the whole into a more compact body. The pressure must be

on the lower edge of the hands and must be uniform and steady. Do not raise the hands too rapidly, but when once started, keep moving upward until the top is reached. The main problem is to learn to get just the right pressure and to move upward slowly and steadily to the very top. The movement upward must be just fast enough to make a spiral line on the clay like cutting a thread, and yet not so fast as to leave any clay untouched. Right at the top lessen the pressure some, or the clay will be inclined to go to a point. Continue the drawing-up process until a cylinder is formed some 6 in. high. Then compress the whole mass back again into the smooth half dome. This compressing can be done with the right hand pressing on top and the left acting as a guide on the side. It is well, too, to repeat the process of drawing up and pressing down until the methods involved have become somewhat familiar and there has grown a feeling for the clay. Remember also that water is the lubricant and must be used frequently. Keep the hands moist at all times during the work.

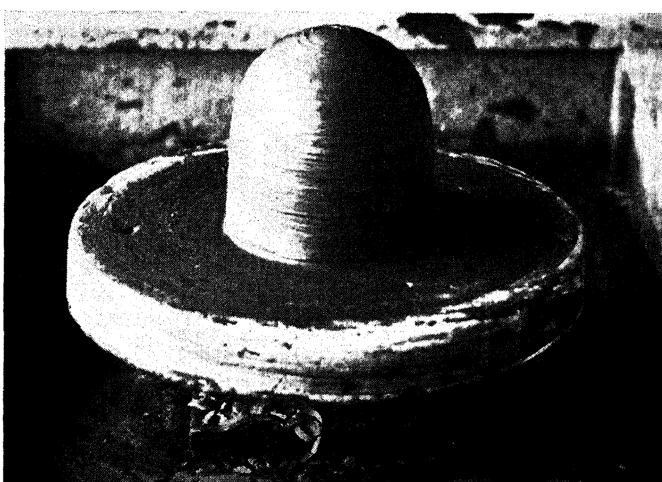


Fig. 68. The first important step is to center the clay. Force the ball of clay down upon the wheel until it sticks firmly to the head. With the left hand held rigidly to the clay and the right hand pulling gently, force the clay into the center of the wheel. Place the right hand down on top of the mound and again mash the clay down. Continue forcing in and pressing down until the clay is perfectly centered. Have the mound as near as possible to the size of the piece that is to be made. Keep the hands well moistened.

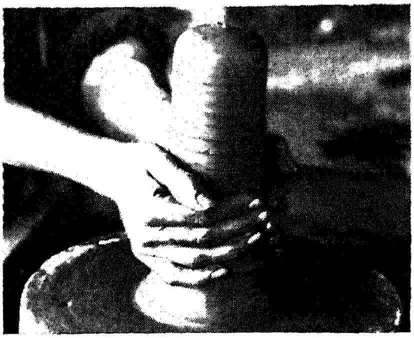


Fig. 69. The second step in throwing is the drawing up and compressing of the clay to get rid of all air pockets. Note the position of the hands and that pressure is from the lower part of the palm, working evenly and steadily to the top. Continue upward with a slow, even movement, slightly releasing pressure when the top is reached. Press the clay back with the right hand on top and the left hand as a guide on the side, moving down until the center mound is again formed. Repeat the process until the clay is in good condition and free from holes.

Fig. 70. In the third step the hole is made in the center of the mound. With the left hand gently resting against the mound, drill a hole with the right thumb into its center down to within ½ in. of the wheel head. Use plenty of water on the hands.

The first piece to be made should be a bowl, as the problems involved are less difficult. At this point, shape the half dome so that its bottom will be about the size of the bottom of the bowl to be made.

Making a Cylinder. The next step in throwing the piece is making the walls, and to do this a plain cylinder first is made. This can be done by two methods.

The first method is as follows: With the hand well moistened, drill a hole in the center of the clay with the right thumb. Make the hole extend down into the mound until the thumb is within ½ in. of the wheel head. With the left hand resting lightly on the outside to help keep the shape true, take the first two fingers of the right hand and enlarge the hole just made in the center. Make the sides of this hole straight and not larger at the top than at the bottom. For a moment, hold both hands on the outside with the thumbs lightly resting over the edge of the hole so that all will be smooth and even. Place the palm of the left hand on the outside, and the fingers of the right on the inside, and with the thumb of the right resting on the first knuckle of the left, press in gently from the outside on the clay, and at the same

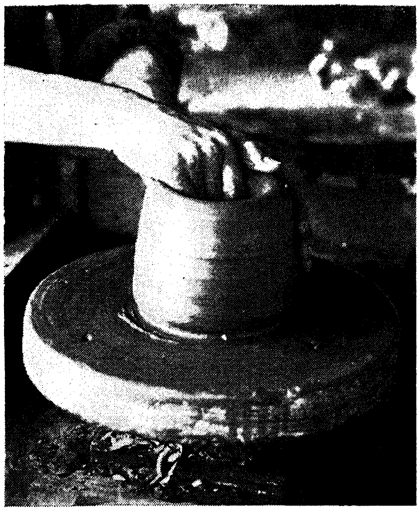


Fig. 71. In the fourth step the hole is enlarged. With the fingers of the right hand reaching to the bottom of the hole, draw out gently, enlarging the opening. Rest the left thumb on the edge to get rid of any surplus clay, and with the left palm press in enough to center the hole exactly.

Fig. 72. In the fifth step the sides or walls of the cylinder are drawn up by holding the hands in either of two positions. Using the first position, place the left palm on the outside and the fingers of the right hand inside, opposite the palm on the outside, with the right thumb resting on the back of the left as a guide. Press firmly but gently into the clay from the outside, and slowly raise the hands giving the mass time to make a complete revolution in each new place. When near the top, release the pressure, but hold the position until the clay runs true. Repeat the process until a thin, cylindrical wall is formed. Figure 73 shows the second position for this step.

time slowly raise the hands. In doing this, start the pressure from the bottom next to the wheel head, with the outside pressure a little heavier than the inside. Continue to raise the hands until the top of the clay is reached. At the top, slowly release the pressure, but hold the position until all runs true. Moisten the hands, and gently place the thumbs over the top edge to keep it in perfect condition. Now repeat the process of drawing up and forming the walls, until a perfect cylinder is made with a slight taper inward toward the top and with the wall approximately ½ in. thick.

In the second method of completing the same process of wall formation, place the fingers of the left hand inside the clay with the palm facing the wall. Cup in the fingers of the right hand, and rest the thumb near the end of the first finger but inclined toward the second. Rest the thumb of the left hand on the base of the right. This places the tips of the left fingers on the inside opposite the side of the first joints of the right, making a much smaller point of contact. The thumb of the left resting at the base of the right thumb acts as a guide for the

two hands so that they will not be drawn out of line. The pressure in both methods must be made only at the one point of contact and never all the way up, and must begin at the bottom, and be slowly and evenly raised toward the top. Lessen the pressure at the top, with a little heavier contact on the outside than inside. Clay stretches more easily than it compresses, so that it is well to keep the shape slightly undersize rather than oversize.

The very fact that the point of contact in this method is smaller makes the work easier to be seen, and you are less likely to press the whole wall at once. However, the very smallness of the contact demands a greater degree of skill to hold the fingers opposite one another; and, too, as the piece grows taller, the thumb of the left can no longer steady the hands by resting near the wrist of the right. Thus the two methods have their advantages and disadvantages, but both should be mastered for they work well together, the first in drawing up the mass and making the sides, and the second in forming the shape.

Fig. 73. The sixth step is more difficult to learn than the method shown in Figure 72. With the thumb and finger tips of the right hand turned in out of the way, the knuckle of the right forefinger is made the main working surface on the outside of the clay. The finger tips of the left hand must work against the right knuckle from the inside, and the left thumb should rest firmly against the top of the right. The rest of the process is the same as the fifth step. The main problem is to keep the hands steady and opposite one another which becomes difficult when the clay gets too high for the thumb to act as a steady rest.

Fig. 74. The seventh step shows the use of the rib in truing up the walls after the inside has been ribbed and sponged. No matter what form is to be made, a cylinder is first thrown to obtain the correct thickness of the walls and to give an opportunity to finish off the inside and outside.

If, when the cylinder is drawn up as thin as possible, it is decided that the diameter is too great, the piece can be made more slender and taller in exactly the same manner as the drawing up was done in the first steps. This not only compresses the walls and makes them thicker, but also decreases the diameter of the cylinder so that when the right size is reached the process must be repeated and the cylinder again made taller. In this step either method of drawing up can be used, though the second will probably be more efficient.

When the right diameter and thickness of the walls have been reached, sponge out the inside very carefully, and then with the rib held in place with the right hand, as in process number two, scrape off the uneven places on the outside.

The last step in this process of bowlmaking is to curve the cylinder into a bowl of the desired shape.

Forming the Bowl. Place the first finger of the right hand on the outside at the bottom and take out the little fillet of clay around the cylinder next to the wheel head. With the hands (see Process Two) start from the bottom, pressing out gently from the inside. Hold the

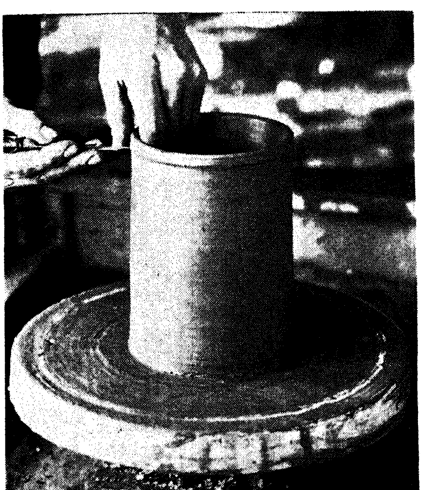


Fig. 75. The eighth step is not absolutely necessary. When the top edge does not run quite true, a small part should be cut away with a sharp-pointed knife held as shown and forced gently into the clay as the wheel revolves.

Fig. 76. In the ninth step the dish or bowl is shaped. In this bowl the second position of holding the hands (Fig. 73) is used and the pressure follows the shape to be made. At the point shown the stress is on the inside, while closer to the top it would be on the outside.

Fig. 77. In the tenth step the piece is cut from the wheel head. Usually it is cut with a wire and removed with the hands. This takes practice, as it is difficult to move as soft a piece as a freshly thrown vase and not spring the form out of shape. A board, as shown in Figure 78, saves the difficulty of moving the piece immediately, but it must be cut from the board to prevent the bottom from cracking.

inside hand a little above the point of contact on the outside. Slowly raise the hands with greater pressure on the inside until the point of greatest diameter is reached, where the process is reversed with the outside hand having the greater pressure and somewhat in advance of the inside position. This last step will bring the top well over and curve the clay into a smooth, even bowl. Now hold the tips of the fingers together on the edge, to see that it remains true, or if the edge is a little too ragged, trim off the surplus clay with the point of a sharp knife. Hold the knife in the right hand and steady it with the left, and while the wheel is revolved slowly, force the knife point gently into the clay. After the edge is trimmed or touched up, rib and sponge the piece again, and touch up any suggestions of air pockets with the pricker. The thickness of the clay also can be tested with the pricker while the piece is in the process of throwing.

When the work has been finished thus far, remove it from the wheel by sliding off the removable board with the dish upon it. The piece must now be set away to stiffen and should be ready in a day or so for the process of turning. After it has set and partially stiffened, run the

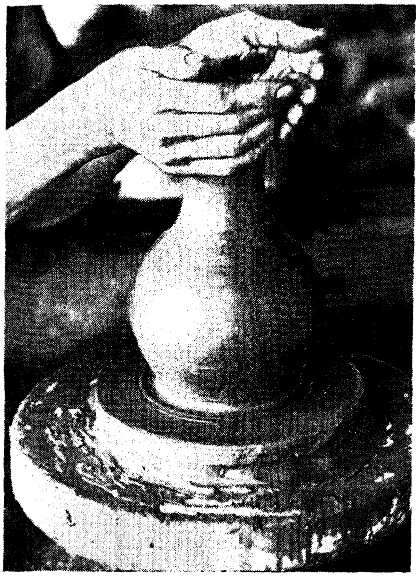


Fig. 78. In the eleventh step, a narrow-necked vase is being made. Here the opening wanted is smaller than the hand. This piece rests upon a board fastened to the plaster wheel head with clay, and can be removed without disturbing the shape.

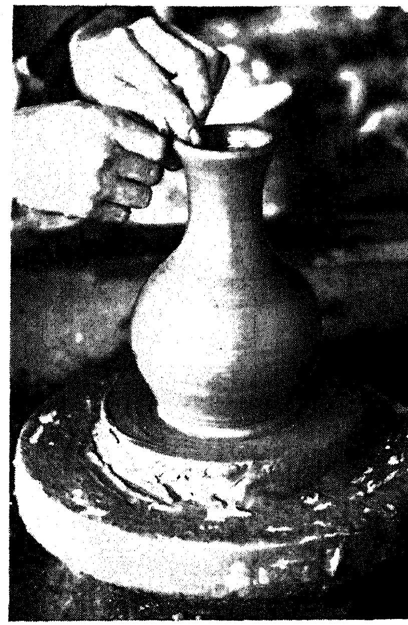


Fig. 79. In the twelfth step is shown the method of holding the fingers in finishing off the edge. This piece is ready to be set aside to stiffen to a leather hardness, and then have the foot turned.

cutting wire under the piece to keep the bottom from adhering to the board and cracking.

Cautions. There are many little kinks and twists in the work that can be learned only by continued practice. But for the most part, there are more failures from not getting the clay well centered and from pressing too hard than from any other cause. The clay, too, must be well wedged, and should be cut and slammed vigorously down upon the wedging board.

Lumps and air pockets will spoil the work whenever they occur. Remember that clay is soft and pliable, and that a finger can be stuck through it easily, so press just hard enough to get results, and no harder. Again, a wheel that runs too fast is much more common than a slow one. Often the beginner grows a little excited or nervous, so that the longer he kicks the wheel the faster he does it. In centering the clay, the wheel can be run comparatively fast, but in the pulling-up

process the speed should be slowed down, especially as the walls approach the right thickness, so as to avoid jarring and settling the clay faster than it is drawn up.

But with all of the sorrows and griefs of learning to be overcome, the effort is still worth while and will repay anyone well who will persevere.

THE POTTER

*Leo G. Schussman**

The potter works at his wheel intent
  On the task of his skillful hands
Which grasp the clay and mould its shape
  In circles of growing bands.

A pressure here and a light touch there
  'Neath the smile of his beaming eye,
Then the soil of the earth that has no shape
  Takes on the form of the sky.

"How can you keep that pace," I asked,
  "Your leg must be all fagged out,
And yet it keeps right on. Pray tell,
  Just what's it all about?"

He kept on going in rhythmic pace,
  Then said with a look inspired,
"The leg that moves is full of pep,
  It's the one I stand on's tired."

So round and round in ceaseless tread
  He whirled the plastic clay,
While into its form he shaped a mould
  Like the hand of destiny.

A few more pats and the whirling disk
  Slows down to the pace of a snail,
And, Lo, there gleams the perferct form
  Of the long-lost Holy Grail.

* Courtesy of Leo G Schussman, Arcata, Calif., author and friend.

CHAPTER VIII

Turning, Trimming, and Drying

AFTER the thrown piece has been allowed to stand until it has dried to a leather-hard condition, it is ready for turning and trimming. This process consists of shaving off the surplus clay, until the piece is of uniform thickness; the process also includes putting a foot on the bottom of the piece. In the case of work taken from a mold, the turning is confined to the spare, which must be trimmed down to the true edge of the dish and then smoothed and evened.

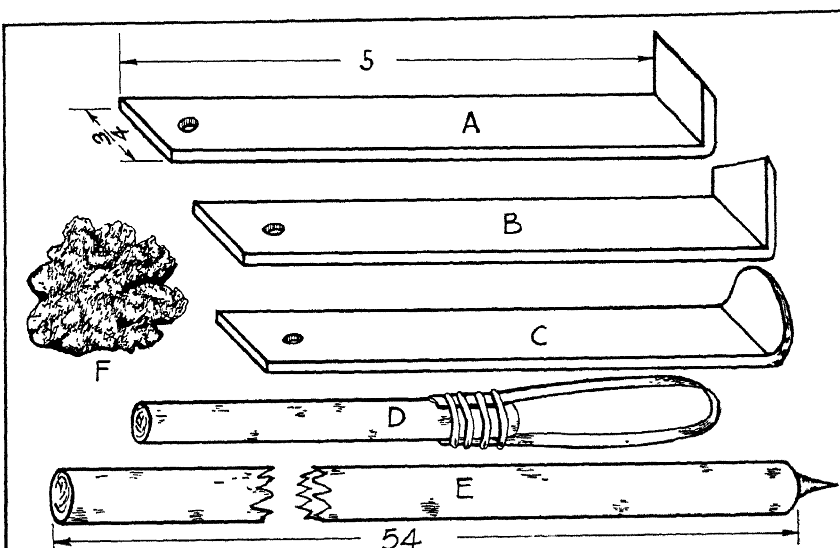


Fig. 82. Turning tools. *A* and *B*, square and skew-pointed tools used in smoothing surfaces; *C* and *D*, roundnosed and loop tools used in making rough cuts; *E*, tool holder or turning stick made from a broom handle with a sharp nail for a spur; *F*, sponge used to wipe the piece when the turning has been completed. The loop tool at *D* is made by wiring a piece of band-saw blade to a round stick

Fig. 83. Centering the piece with the hands.

The equipment for this work is very simple and can be easily made. In Chapter XX on Equipment, detailed directions have been given for making all the tools used in turning. The worker will want a turning stick; roundnosed, skew-pointed, and square-pointed tools; a blunt lead pencil, and a sponge. In place of the regular roundnosed tool, it is advisable to use a loop tool made of a thin strip of steel bent in the form of a loop, with the ends wired to a wooden handle. This loop is especially effective for taking off the outside rough surface.

The Process Itself. When everything is ready, take a piece of pottery and, if it is a thrown piece, turn it upside down upon the wheel head. Placing the palms of the hands on each side of the work, revolve the wheel slowly, and at the same time try to slide the dish to the exact center of the wheel. This preliminary process of centering will be difficult at first, but will become comparatively easy with practice. As soon as the piece feels centered, rest the pencil on the turning stick and test

Fig. 84. Testing the centering with a pencil.

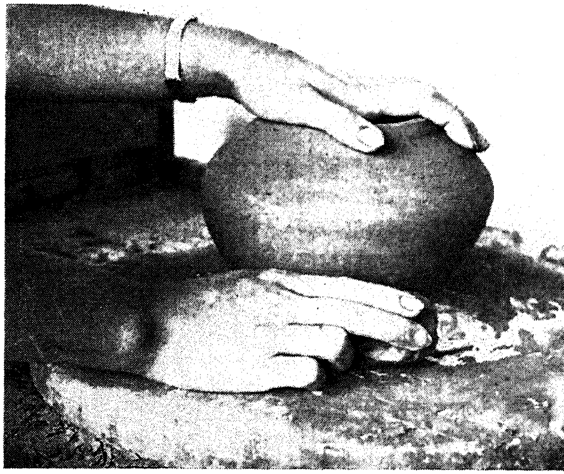


Fig. 85. Fastening the piece to the wheel.

out the centering. If the work is perfectly centered, the pencil will draw a line completely around the piece, but if not, the line will be heavy on one side and not touch at all on the other side. If it is not centered, stop the wheel with the untouched part of the dish directly in front and, placing the hands on the ends of the line, draw the piece toward you half the distance the work is off center. This process will soon get the piece perfectly located and should not take over two or three trials. Now hold the dish down firmly with one hand; with the other hand fasten it securely to the wheel head with pinches of clay. If the piece is a bowl, four lumps about the size of a hen's egg should hold it nicely, if evenly placed on four sides of the work. If, however, a tall vase is being turned, a much larger quantity will have to be used.

Place the turning stick as close to the work as possible. With the round-pointed tool grasped in the right hand much as a pen would be held, press it firmly against the stick with the cutting edge just reaching the work. As the thickest part of a thrown piece of pottery is usually on the edge next to the bottom, turn this edge first and cut it even back to form the correct size. Then turn the bottom off level and to nearly the correct thickness. Begin the turning from the center of the bottom and work out to the outer edge, and not from the outer edge in. It will be noted, however, that the roundnosed or roughing-off tool leaves the

surface rough. In fact, considerable difficulty may be experienced at first in turning off all the clay necessary.

The next step is of a different nature and consists of smoothing off the work which has been done previously. With either the square or skew-pointed tool, trim the outside of the work neatly and smoothly and then go completely over the bottom. Before finishing the bottom, however, the foot must be turned. To do this, take the point of the skew turning tool and cut a neat groove around the outer edge of the bottom about ¼ in., in and at an angle of about 45 deg. This groove should not be deep, about 1/16 to ⅛ in. being ample for all purposes. With the same tool, beginning at the center, turn out the bottom and

Fig. 86. Turning a thrown piece.

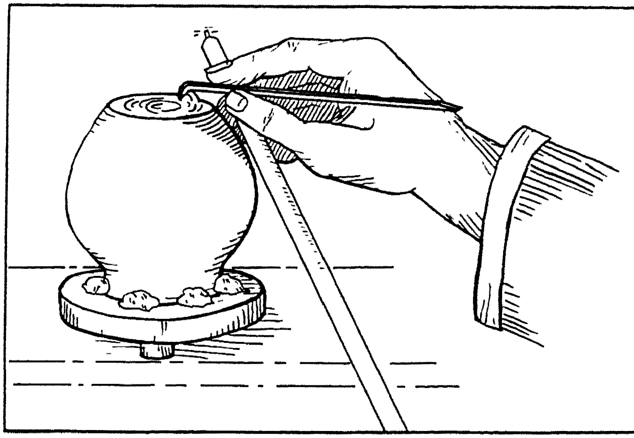


Fig 87 The centered piece is fastened to the wheel head with lumps of clay, and the roughing cut is turned with the round-pointed tool.

leave this ridge on the outer edge. This is called the foot and is indispensable for a good base to the piece.

After all the turning has been completed fill up any small holes or defects with the turned clay, and then, with a moist sponge, wipe off the surface until the entire piece is in a perfect condition. In the sponging be sparing with the water so that the work will not become sticky and

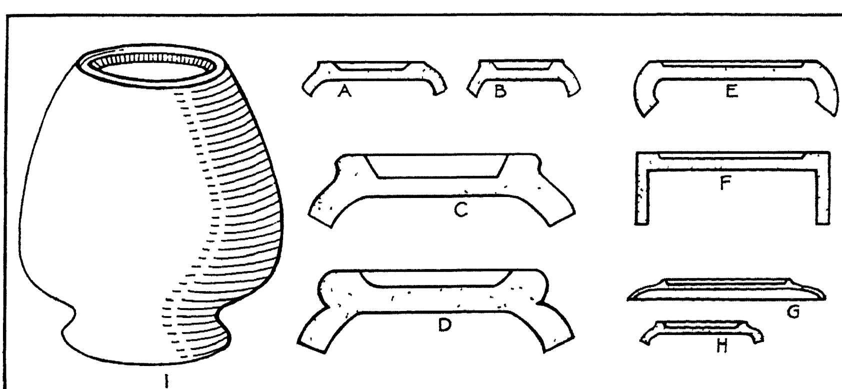


Fig. 88. Every good piece of pottery should have a suitable footing, well adapted to the size and shape of the piece. A number of footings are shown. *A* and *B* are for moderate-sized pieces; *C* and *D* for large shapes; *E* and *F* for bowls and straight-sided pieces; *G* and *H* are for plates, cups, and saucers *I* shows the footing on a finished piece.

hard to handle. To finish the work, take away the wedges, turn the piece right side up, center it, and turn the top and inside. Be sure not to ruin the bottom in centering and wedging the work to the wheel. In fact, if the piece is very moist, it is well to set it aside for awhile. After it has properly set and hardened, the top should be trimmed up and finished.

Turning Cast Pieces. As mentioned in the first part of the chapter, the turning of cast pieces is much simpler than thrown pieces. However, the work must be carefully done, if the results are to look at all worth while. When the cast piece first comes from the mold, go over it carefully and retouch any defects such as air holes, parting line, and the like. Set it aside to stiffen to leather hardness; then turn it at the top and carefully sponge it. This turning can also be done when the casting is dry, but it is then much more difficult and the danger of breakage is increased. Before performing this operation, it is best to wipe the piece with a damp sponge.

Center the leather-hard casting, top up, on the wheel in the same manner as a thrown dish is centered. Fasten the work solidly, and, if the spare is wide, take the point of a sharp knife and, holding it on the turning stick, cut most of the spare off evenly. Feed the point of the knife slowly into the clay and do not revolve the wheel rapidly. In that way little difficulty will be met in this step. Now, with the round or skew-pointed tool, turn the remaining spare down to the edge of the piece, and sponge off the surface thoroughly to complete the work.

Drying. Every pottery shop, as a part of its regular equipment, needs several good cupboards for drying and storing the unfired pottery, the wet molds, and the freshly glazed ware. These cupboards should be spacious and furnished with some type of artificial heat, preferably electricity.

Molds will not be injured if they are kept at a very warm temperature, about 100 to 150 deg. Fahrenheit, or even more. The unfired clayware must be treated with much more care. Cast pieces will stand considerable forcing if the heat is applied evenly, but the heavier ware from the wheel must be treated with a great deal of caution.

After a piece of thrown ware has been taken from the wheel, it should stiffen in the temperature of an ordinary room until leather hard, and when the turning and sponging have been completed, it is well to allow the piece to stand again for a time before forcing the

drying, especially if the clay is quite thick. When the outer surface has dried fairly well, artificial heat can be employed without serious damage, and the drying finished more quickly.

Of course, in some climates the atmosphere may be so dry that care must be taken that the pieces are not cracked or warped under the ordinary conditions of room or out-of-doors air drying, and at any time it is well to avoid placing the work in the direct rays of the sun. A well-circulated, warm, dry air, which will rapidly carry off the moisture, and yet not dry pieces on one side to the detriment of the other, would be a nearly ideal situation.

Whatever the process, the drying should be uniform and very thorough. Under no circumstances should a partly dried thick piece be allowed to go into a kiln, for wet pieces not only crack, but crack and fly in every direction, breaking and doing damage to everything in reach. When the pieces are thoroughly dry, they should be gone over and any defects sandpapered, after which they are ready for the kilns.

Another cupboard should be ready for the drying of the freshly glazed ware. This can be kept at a moderately high temperature, as there is not the danger of breakage to which the green pieces are subject. This cupboard should be ample enough to hold the glazed work at hand, and should have its shelves so arranged as to be accessible for the different colors.

CHAPTER IX

Throwing Large Pieces

NEARLY every individual who has worked seriously in the production of pottery receives orders from time to time for large pieces. This demand may not be regular enough to pay for the expense and labor of making large molds. Then, too, large molds are

Fig. 91. An example of sectional throwing.

difficult and heavy to handle in casting, and even at times require a process of pressing, so that some other method of production is often desirable.

Throwing large shapes demands a background of wide experience which the beginner may not have. It is, therefore, well to develop some other method which will fill the immediate need so that the young artist may not be handicapped in any way.

Throwing in Sections. It is true that a large piece can be built by hand by using large coils and then turning the vase true on the potter's wheel when the clay is leather hard. However, a better way is to throw the large work in sections and then fit them together as soon as the clay is stiff enough to handle. In fact, the process offers a challenge to the skill of the ceramic student and makes a rigid demand upon his dexterity.

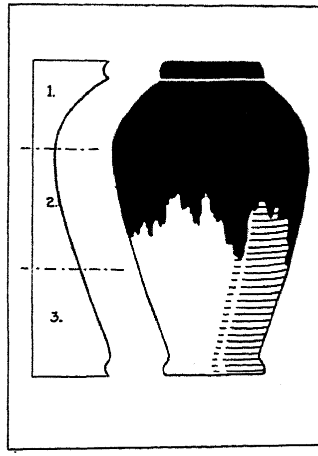


Fig. 92. A three-section pattern for a moderately tall piece. The shading suggests a design for glazing the finished piece.

For the first step in the process, cut a full-sized cross-section pattern and also a template of one half of the vase. Do this carefully and accurately, taking the shrinkage of the clay into consideration so that mistakes will not occur later when the sections are being thrown and the piece finished. Cut the pattern out of heavy construction paper so that it can be saved for future use.

Upon both the cross-section pattern (the section outside the pattern) and the template, lay off the number of divisions into which the piece is to be thrown. These sections should not be so large as to cause any difficulty in throwing them accurately.

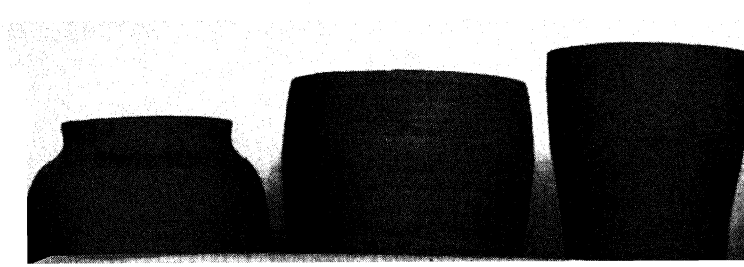


Fig. 93. The three sections thrown.

Trace the contour or template piece on thin wood or stiff cardboard, and cut out and number all the sections. Next, make plaster bats or wooden disks of a size large enough to accommodate the diameter of the largest sections. With a large pair of calipers, a sponge, a sharp-pointed knife, and plenty of clay, you are now ready to throw the piece.

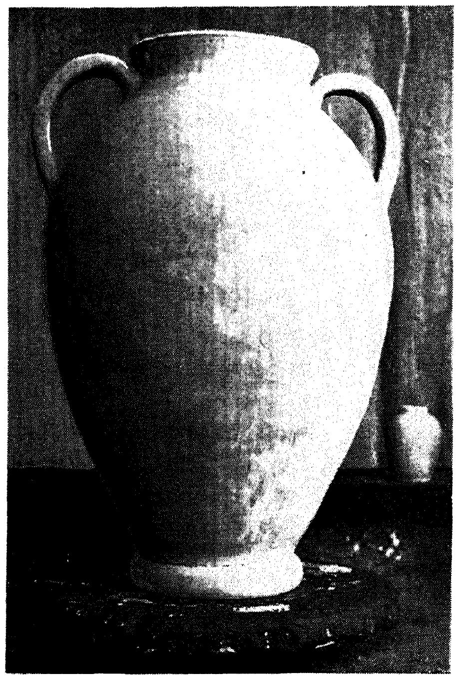


Fig. 94. The finished unfired piece.

Beginning the Piece. Place the pattern in full view of the wheel, and on the wheel head fasten one of the bats or boards. Choose a lump of well-wedged clay large enough to make the bottom section. With the calipers and the section of the template marked for the bottom in readiness, begin the process of throwing. At first, form a cylinder, the exact size of the bottom, using the calipers to be sure the work is right. Draw the cylinder up to a height considerably greater than the section called for. Take the template and deftly draw the cylinder out to the exact outline of the base piece. With the knife, trim off the surplus clay

until the height is exactly what is called for, using the template and calipers as a guide. Sponge off the surface to a smooth, even polish but leave the top edge flat instead of rounded.

Remove this section from the wheel and set it aside to stiffen, beginning immediately with the next section. The process on the next and all the remaining sections is the same, except that no bottoms are needed. Throw all sections with comparatively thick walls so as to permit some turning and trimming in the fitting process.

Now set all pieces aside to stiffen, and watch them carefully to see that all stiffen evenly.

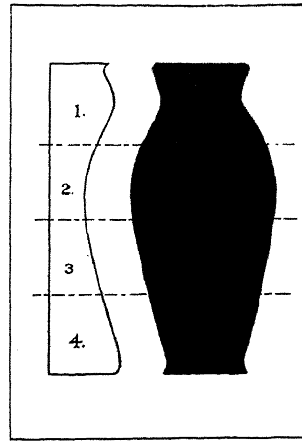


Fig. 95. A four-section pattern and the template for a tall piece.

Joining the Sections. As soon as the pieces are stiff enough to be handled and hold their own weight and form, begin the joining process. Center the bottom section upside down upon the wheel; then carefully turn a good strong foot on the bottom, and remove any surplus clay from the outside. Recenter the bottom piece right side up, and remove any irregularities from the top edge. Set this section to one side and take the next in order and turn it free of defects so as to fit perfectly to the bottom section. To do this, turn the edge first that fits directly to the bottom so that the bottom can be tried on it without removing this section from the wheel. From this piece, take each section in order and turn it to fit in its proper shape.

When all the pieces are turned, recenter the bottom on the wheel and,

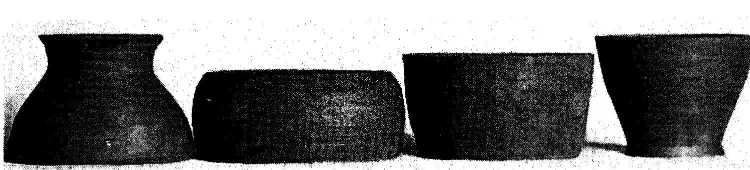


Fig. 96. The various thrown sections in order ready to be turned and fitted together.

with a good supply of thick, creamy slip, fasten the pieces together in order. Apply the slip with a small, soft brush, but, whatever the method, be sure to cover every part of the edges to be fastened with slip.

As the pieces are fastened section to section, go over the joints with a modeling tool and small lumps of clay to fill out every defect perfectly. Slowly revolve the wheel while the building is going on to be sure that the piece is running true to form, at the same time trimming off irregularities. Sponge the entire vase and then set it aside to dry slowly.

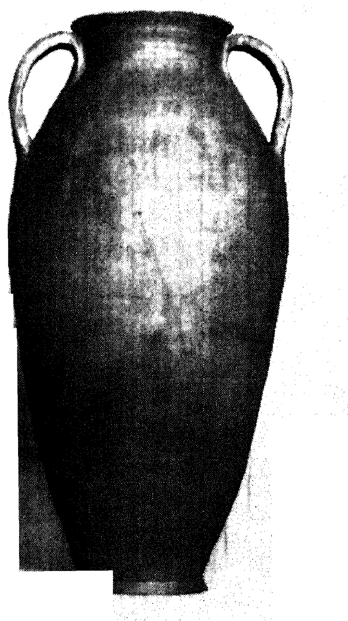
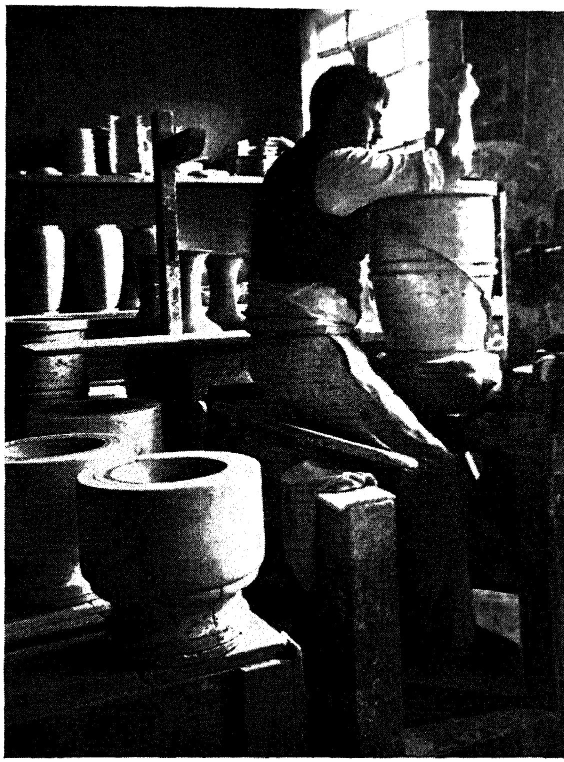


Fig. 97. With thrown and all large pieces, the greatest care must be taken to dry the pieces slowly. The body of a piece of this size is very dense and must have time to dry. Forcing in a drying cupboard would only result in breakage and loss.

By carefully following this plan, very large pieces may be thrown. This method is within the range of anyone fairly skillful on the wheel. At first, only moderate-sized pieces should be undertaken, and as one's experience and training grow he can make any shape and size he wishes.

As in other lines of the work, the risk is much greater as the pieces grow in size, but on the other hand, the reward also grows and is commensurate with the risk. It is a process well worth trying.



Keystone View, N. Y.

Fig. 98. Here a workman is making large pieces entirely with molds on a simple kick wheel. He is filling a section of a mold, using a template to line the walls with clay. On a table behind him are some of the filled sections, which, when finished, will be put together in one complete piece and set aside to stiffen.

CHAPTER X

Tilemaking

TILEMAKING offers a field of varied interests to the worker in clay, and may be carried on with several distinct aims. There are tile intended especially for bathrooms, kitchen drainboards, floors, and other similar surfaces. Again, there are decorative tile, especially ornamented for fireplaces, along with small tile which are made for complicated mosaic designs. Each design, along with others not mentioned, gives an opportunity to challenge the interest of the individual, and demands many hours of careful study to make a product worth while.

It seems best, however, in this brief book, not to try to discuss all the various methods which might be used, but rather to cover as clearly as possible the simplest methods of obtaining satisfactory results.

Making Ornamental Tile. There is a simple type of tile which offers an interesting field. It was not mentioned previously but is of a direct, practical value in the home. It belongs to the ornamental group, and is known as tea or ornamental tile, and is used on the table for hot dishes or as decorative ornaments to give color about the home.

There are a number of methods for making these tiles, but one of the simplest is a plaster of Paris process. From a piece of soft, clear-grained wood, cut a pattern the size of the tile desired, making a proportionate allowance for the shrinkage of the clay. Usually a 6-in. tile, ½ in. thick, is quite satisfactory, because, when finished, it is approximately 5½ in. by ⅜ in. This type of tile may be cut to any shape, though square or round are the two most common forms. If the shape chosen is round, a wood-turning lathe is almost a practical necessity in order to get an accurate pattern from which to make the mold. If the shop does not possess a lathe, the pattern can be made from plaster on the potter's wheel. By whatever method the work is done, several points should be

remembered: (1) to make allowance for shrinkage; (2) to taper the sides of the pattern slightly so that it will draw from the mold; (3) to leave a margin of at least 1 in. all around the pattern to tie the linoleum to, and to aid in removing the form from the plaster.

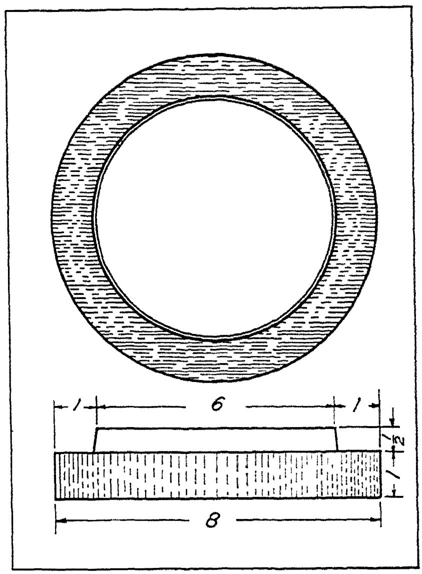


FIG. 101. This circular pattern for a 6-in. tile may be turned from a 1½-in. block of wood. The actual tile form is the unshaded part of the drawing. Note the slant of the ½-in. edge which enables the tile to be drawn easily from the plaster.

Preparing the Mold. Give the wooden pattern a good coating of oil to keep it from absorbing water. If a plaster pattern is used, size the surface well with soap size. On the wood, the oil will act as a sizing. Tie a strip of linoleum around the pattern, or, if square, use a board frame. Mix the plaster and pour it into the form. When the plaster has set and grown warm, pry the pattern out gently with a steel case knife. Retouch any defective spots, and then fit the design planned for the tile in the bottom of the mold. With a pencil, go over the outline of the design and stamp it into the plaster with a gentle pressure of the pencil.

Remove the drawing when the tracing is done, and the design will be found transferred to the surface of the plaster.

Two methods may be used to develop the design. Any cut or mark made in this mold will be found in relief on the finished tile. It is possible, therefore, to cut away any part that is desired in raised form, the height of the relief being governed by depth of the cut. On the other hand, the entire outline may be veined out with a small veining

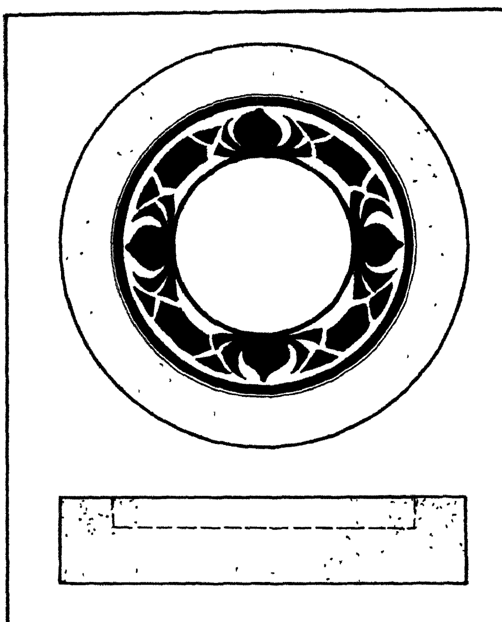


Fig. 102. A tile mold cast in plaster with the design incised.

tool and the same results may be had. The matter is left to the worker's choice. Probably it is well to try both methods. Nearly all designs lend themselves nicely to the veining process, though some look better cut in part in low relief. The veining process should be just deep enough to hold the different colored glazes that are used; that is, the veins should be approximately 1/16 in. deep. With this outline a very effective color study can be made. Place the colored glazes on the surfaces between the veins which should be left bare with only a light coating of clear glaze.

When fired, these veins will show a light tracery over the tile and give a very pleasing effect. When the mold has been completed with its design, lay it away in the drying cupboard for a short time to dry.

When the mold is ready, the process of making or pressing out the tile is very simple. To try the mold, regular pottery clay can be used, though the addition of grog, which is a refractory material like crushed brick, will aid in preventing warpage. On a piece of cloth, roll out a

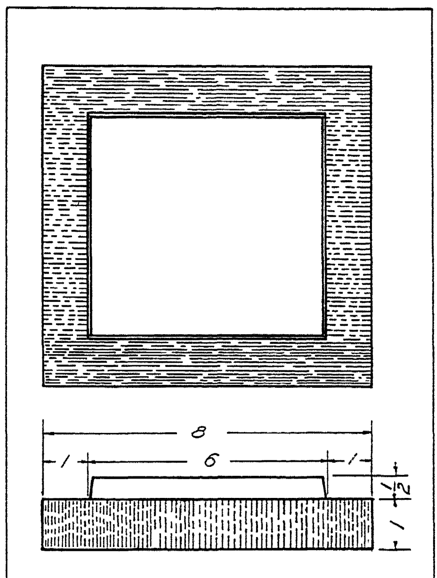


Fig. 103. The square tile pattern may be made from two pieces of board, one ½ in thick glued to another 1 in. thick. In all tile patterns the additional wood makes it possible to remove the form from the plaster.

sheet of clay about ½ in. thick and large enough to cover the mold. Place this clay with care in the mold with the smoothest face toward the design. Press the clay very thoroughly into every unit and corner, going over the entire surface carefully with thumb and fingers. Fill the mold up over the top and cut off the surplus with a wire. With a knife or straightedge, true up the surface level with the mold, and then sponge off any defects. Now turn the mold over and rap it gently on

the edge of the table, holding the hand so as to catch the tile. If the mold is made correctly, the tile should fall out easily, after which the process can be repeated for as many tiles as may be wanted.

Drying Tile. Drying tile is quite a problem and demands considerable patience and skill. The air must circulate freely around the entire tile, or warpage will result.

As soon as the freshly made tiles are stiff enough to be handled, place them in piles of six or eight, with thin strips of wood between them as separators. It is usually well to use three of these narrow strips to a tile, beginning from the bottom up. The strip should not be over ½ in. wide, about ¼ in. thick, and just long enough to reach across the tile. On top of the pile of tiles, place a small weight to keep the mass even. Let the tiles stand until dry, but examine them occasionally to see that all is well.

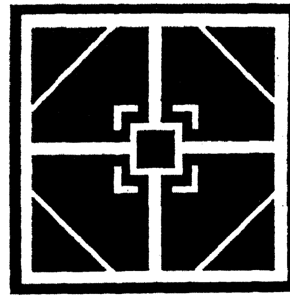


Fig. 104. A suggested square tile pattern that may be incised or veined out.

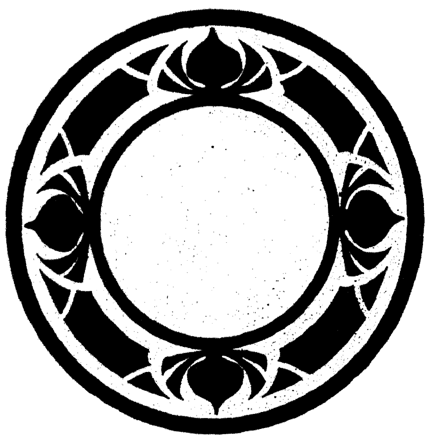


Fig. 105. From a prepared pattern make a plaster mold the size of the tile desired. Stamp the design in the bottom of this mold, and with a sharp, chisel-like tool, scrape away the design to a depth of 1/16 in. This will give a tile with raised design and a depressed background. The design should be glazed with an appropriate combination of colors, and fired once in the glost firing.

Retouching and Applying Color. When dry, take the tiles down and examine them. Retouch or discard all defective ones, and then carefully sand the perfect ones. Since there is no problem of holding water, and, resting as they do, on the horizontal, you may now glaze the unfired clay tiles. You may apply the glaze with a brush, using all

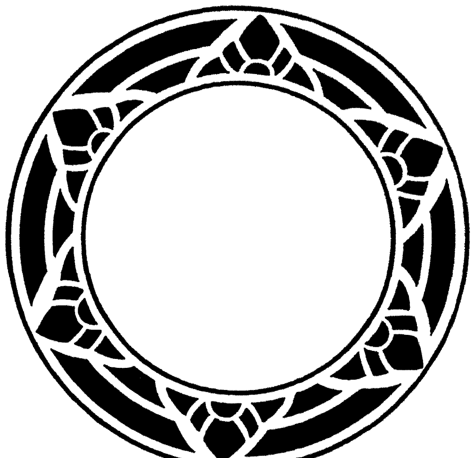


Fig. 106. Prepare the mold, and stamp the design on the inside by going over the outline with a pencil. With a six-penny finish nail, ground to a rounded point, go over the entire outline, veining out a little groove about 1/16 in. deep. If the pattern is veined properly, the tile, when pressed, will show an outline of the design in delicate relief.

one color or a color scheme with a variety of glazes. Both methods are effective and are not difficult, though the color-scheme process is a much slower one and should not be undertaken if the worker is in a hurry. In the color process be sure to put the glaze on evenly over the entire tile, and take every precaution to avoid getting the glaze colors mixed with drops of color from the different batches. If the veining method was used in making the tile, have the glaze come up level with the top of each little ridge so that the glaze will be evenly thick. This will leave the ridges as a fine tracery over the tile. Over this tracery place a thin coat of clear glaze so as to cover the whole surface well. The bottoms of the tiles do not need any glaze, as it is customary to glue felt to them to act as a padding for the tile on the table.

Firing. In firing, place the tiles in tile boxes, which are merely refractory, clay-fired boxes, of a size large enough to hold one tile each, the bottom of one box forming the cover for the one above. This permits the packer to stack a number of tiles into a comparatively small space. If nothing but tiles are fired in the kiln, shelves may be so arranged as to take the place of the boxes. On the other hand, if only an occasional tile is to be fired, the problem can be solved by placing the tiles on the top of unglazed pieces in the biscuit kiln.

The Metropolitan Museum of Art
Danish twentieth-century stoneware bottle.

CHAPTER XI

Pressing and Making Irregular Shapes

IN SOME types of molds, casting is not always a convenient method of production, so that some other system must be resorted to in order to get the best results. This is particularly true in the case of the very large molds which are too heavy to be handled when full of slip, and are in every way difficult to manage. In doing such large jobs, pressing is a great help to the worker in clay. Pressing can also be used in any openmouthed mold where a particularly sturdy looking piece is wanted.

Pressing Methods. On a piece of cloth, roll out a slab of clay to

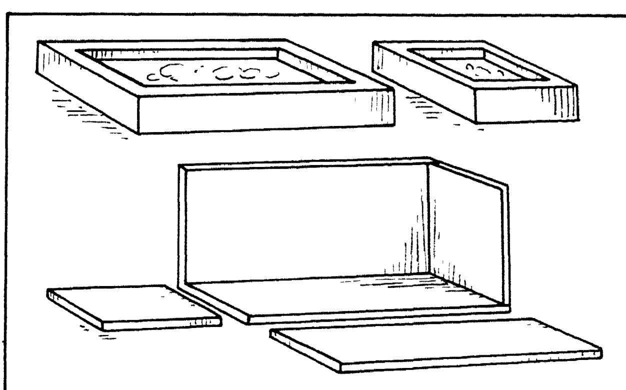


Fig. 109 A sectional pressed piece. Some work, having a complicated design, need not be modeled on all four sides, but may be produced as shown. Molds of one side and an end are made and the parts pressed out and laid on cardboard for convenience in handling. The bottom then is rolled out and the sides and ends mounted upon it. Slip must be used between all contacting surfaces, and the greatest care shown in rubbing up the joints.

practically the thickness of the desired dish. Sponge out the pieces of the mold, and then fit the rolled clay to one of these sections, being very sure to press the clay carefully into every detail of the mold. Repeat the process with every section of the mold until it is well covered, and then fit the sections together and tie firmly in place. Next, go over the joints in the inside of the mold and rub the clay firmly together. Sponge off the surface smoothly with a soft sponge, and then set aside for a few hours to stiffen. Unless the piece is very large, the mold can be taken away from the form in a short time, as the clay, to begin with, is

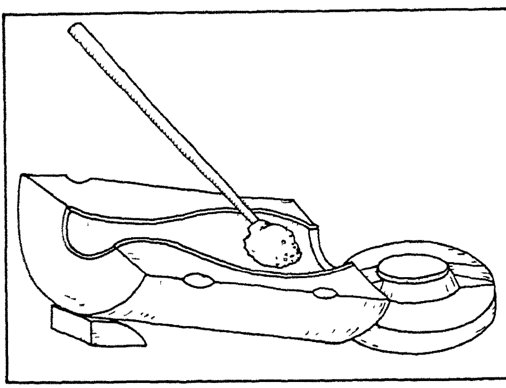


Fig. 110. Before pressing clay into a section of a mold, it must first be rolled out in large sheets and placed into the half of the mold. It is then pressed down with the hands and a sponge, and the edges are trimmed off even with the plaster. The clay must be pressed well into every detail of the mold. After each section has had its clay, the mold is tied together and the joints are gone over carefully with extra clay. The sponge on the stick is useful in deep, narrow-necked forms.

much stiffer than casting clay. When the mold is removed, the same process must be gone through as if the piece had been cast. In fact, the necessary retouching is usually rather more than in casting, due to minor defects which are likely to creep in during the pressing.

For large pieces, a stiffer, more refractory clay may be needed to make the ware hold its shape. Under such conditions, add a little fire clay or even a measure of grog to produce the desired effect. Saggers will all need to be pressed out and should have approximately the same texture

as the shelving mixture, which was one third grog and two thirds fire clay.

Form Boxes and Irregular Shapes. Clay objects, out of the round, are more likely to break or warp in drying and firing than are round ones. This is probably due to the more uneven expansion and contraction. However, it is not at all impractical to build shapes of this kind, and many times they can be made very attractive. Several processes, too, are possible for the worker, such as hand building, carving the pattern, making the molding and casting, but where only a few pieces are

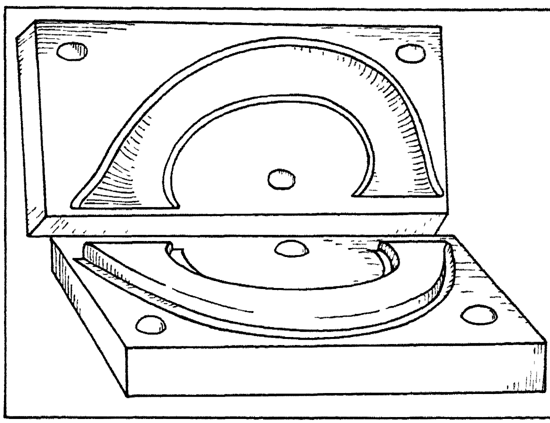


Fig. 111. Handles are pressed instead of being cast. To do this efficiently, a small groove is cut in the plaster around the edge next the impression. This groove takes up the surplus clay and permits the mold to go together more easily.

needed, a rather interesting method can be used. Model a panel of one side and an end of the proposed box. Make a plaster mold of these two pieces and then partially dry the two molds. Press from these molds two sides and two ends and lay them to one side ready for use. Roll out a clay slab large enough for the bottom of the box, and upon this bottom set up the two sides and ends, sticking the whole together with slip to make the desired piece. To aid in handling the parts, it is sometimes well to cut stiff pieces of cardboard upon which to lay the sections. Every precaution will have to be used to make the piece a success, but as a whole the method is worth trying. It is a timesaver where the piece to be made is very elaborately modeled, and will pay, if nothing else, as a means of making a pattern for a mold.

Tiles, book ends, and many lines of novelties can be produced by the pressing process, which for such articles is quite satisfactory because of the ease of handling, the brief use of the mold, and the lack of mold drying, which plays such a large part in the casting process.

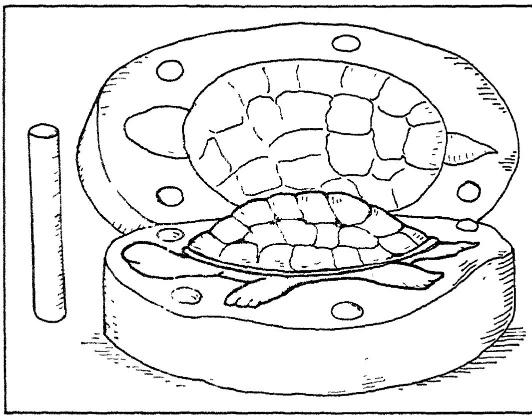


Fig 112. A model of a turtle makes an attractive insert, and is not difficult to make into a mold. Here is shown a model pressed and ready to be taken out and pierced with the piercing tool lying next to the mold

CHAPTER XII

Clay Work in the School

FOR many years the author has studied the problem of finding materials for suitable handwork in the average schoolroom, and has had many pleasing results from experimenting with the development of various products. A long list of materials, which have educational values and which interest the children, may be made. However, there is one difficulty which is always to be met, and that is the cost. Many of the very delightful types of industrial-arts and construction work for the grades are so expensive that they are quite prohibitive. It would then seem only natural to use clay, a material which has been so plentifully deposited over the world as to be within the range of every teacher.

Clay and Its Possibilities. There is hardly a material known which will offer as wide a range for expression as clay. Its plasticity lends itself to every touch, and yet, when fired, it becomes imperishable as rock. The equipment, too, is so simple that it need not trouble anyone. The first step is to locate the clay. If the school is situated in a city of moderate size, the children will be able to tell of a frequented clay

Fig. 115. These animals were modeled by a fifth-grade Indian boy from pictures. He had no other assistance.

Fig. 116. Children never tire making these Googum Birds, especially when bright colors are used The head, body, and feet are made of clay, the legs, neck, and beak of wood, and the plumage of dyed chicken feathers.

bank. If they fail in locating the desired material, a trip along almost any highway will disclose the product cropping out from a cut or lying in large lumps, much to the annoyance of the maintenance division. Permission to take away any quantity of such clay can easily be obtained. The only limitation, as a rule, is the assurance not to injure the grade and cause further washing. If clay is not readily found along the roads, a cross-country hike will usually disclose the product cropping out from some bank. For classroom use, the color and melting point need cause little worry, the main point is to have the clay as free as possible from foreign particles, such as rocks, roots, and sticks. It should be dug in quantities large enough to last for the school year, and then be stored away to dry.

When needed for class use, it should be placed in a container of water to soak a day or two in advance of its use, after which it can be dipped out and set upon boards to stiffen, or put into plaster bowls. The stiffened clay next should be wedged or kneaded like bread dough, until it is ready for use. Clay can be stored in a large crock, an old candy bucket, or other container, and will keep indefinitely if covered with a damp cloth. If there is no clay in the neighborhood, or if the school is in a large city, clay can be obtained easily either from a pottery firm, a brickyard, or a regular supply house.

On a piece of oilcloth spread over the desk, the child may be set to work. The hands are practically all that are necessary, though a few tools of wood or metal are convenient at times for small detail.

Many objects besides pottery can be made. Animals, toys, leaves, fruit, houses, and machines can all be modeled.

It would be well, at first, to build small pieces which can be completed within a short time, and the more difficult pieces when experience has been obtained. In the school pottery, either the coil or the strip method may be used, though the former can be done with less trouble. For large pieces and finished work, the use of the rolled-strip method will prove more rapid and reliable and will result in fewer defective pieces caused by poor joints.

Damp cupboards are not needed if the work is planned so as to be finished in one lesson or work period. If, however, it is desirable to hold some work over until another day, an old box with a tight cover, and with wet cloths on the bottom, will solve the problem.

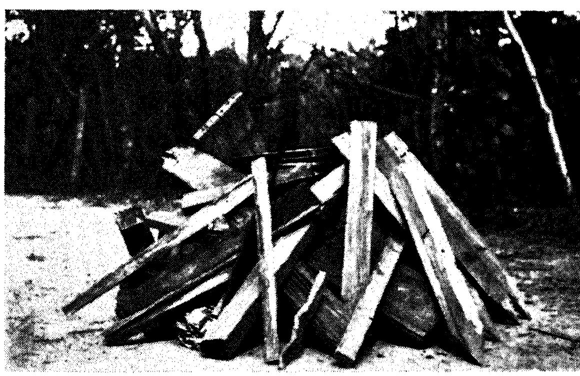


Fig. 117. In the bonfire method of firing, the pottery is placed in an old can filled with dry sand. The can is surrounded with wood which should be kept burning briskly for several hours. The can should not be opened until everything has been cooled completely.

Preserving the Work. Only those pieces which show superior or representative work should be saved, as the clay is in no way damaged by continued use. If there is any feeling on the sanitary side about using clay again, a small quantity of lysol added to the water when dissolving the clay will overcome these objections.

The matter of firing the permanent work is not difficult, if the individual has access to a stove, a fireplace, or a campfire. The caution to be remembered in all such work is to increase and decrease the heat slowly. This can be done by protecting the pieces from the sudden

fluctuations of heat and cold by burying them in dry sand in some old container. This protective covering, it must be remembered, is quite effective in keeping out the heat so that the firing must be carried on for several hours until the work can be brought to a hard state. Firing cannot be done in an oven or on top of a stove, as the heat is not great enough to change the clay to rock.

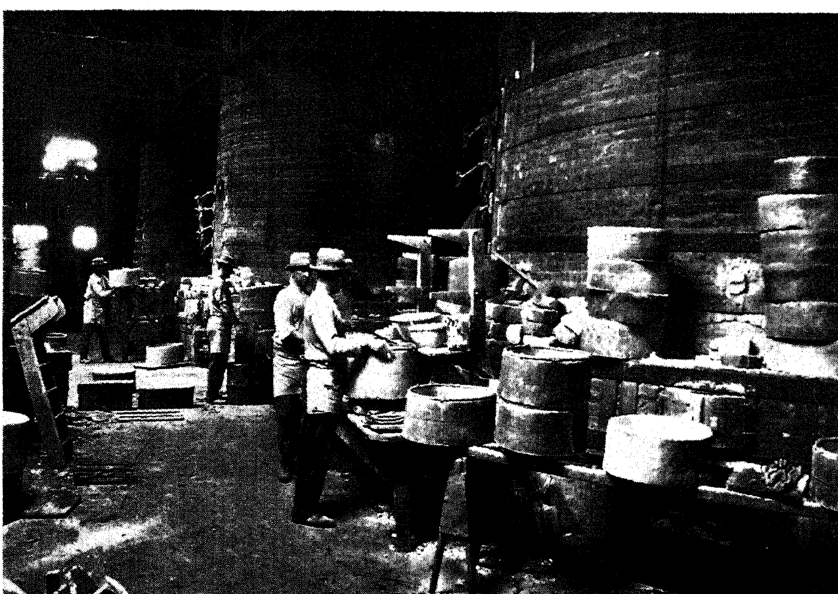
Decorating. To color and waterproof the work is a short matter. First, fill the pores with a good wood filler, and then paint the piece with any lacquer or paint. Be sure that the filler is dry before the color is applied. Many color combinations and effects can be obtained by using different colors, golds, and gilts, and by varying the methods of application. One rather interesting method of applying paint is accomplished by pouring some of the desired colors on the surface of water in a bucket, letting the paint mix in an odd fantastic way, and then dipping the pieces into this mixture. The effects are interesting and worth trying. When once colored, the pieces take on a new touch which pleases the children greatly, and makes the work more worth while. Clay modeling, as taken up in this way, brings to the teacher an aid not to be overlooked, as it solves her handwork problems for many weeks.

Inexpensive water colors or show-card colors may be used to paint Mexican and Indian designs on biscuit-fired pieces. To do this, the pottery should not be sized with shellac or wood filler, but the colors should be painted directly upon the porous piece, after which the outside should be sprayed with clear lacquer, and the inside treated with very hot paraffin. This gives an interesting finish well worth trying.

CHAPTER XIII

Commercial Production

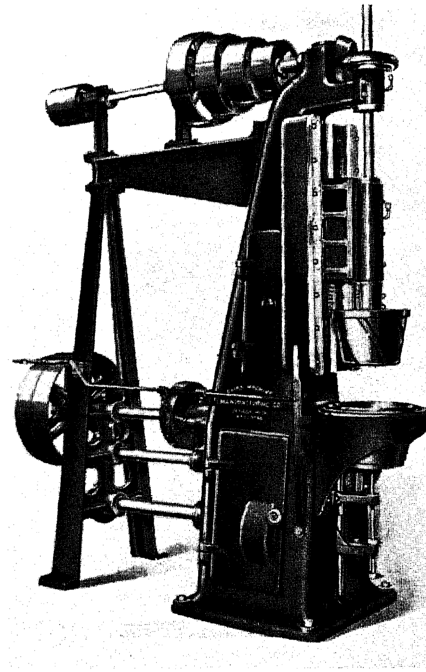
THE aim of this book is to outline pottery procedures of use to the craftsman in his little shop. There is quite a difference between the artist working for the joy of producing a few beautiful pieces and the factory owner turning out thousands of pieces each week. Both the



Keystone View, N. Y.

Fig. 120. It is almost impossible for the studio worker to grasp the enormous size of the modern commercial kiln. Note the saggers which the workmen are handling.

large-scale manufacturer and the individual craftsman are necessary to meet the demands of modern life, and each has an interesting work to do. But in a book like the present, only a few high lights of quantity-production methods can be discussed.



Baird Mchy. & Mfg. Co., Detroit
Fig. 121. An up-to-date pottery molding machine which will turn out material limited only by the worker running it.

Flowerpots, Bowls, and Crocks. An individual interested in the potter's craft can profitably spend several hours visiting a modern commercial plant where flowerpots, bowls, jars, and crocks are made. To watch a workman making flowerpots at the rate of 5000 or more a day is fascinating. Even though the method is mechanical, it is suggestive and certainly important, because it makes possible to the individual of moderate means many things which otherwise would be prohibitive in cost. But what are these mechanical methods? The most rapid process is due to the use of the molding machine, shown in Figure 121. This machine is so geared as to produce pots and bowls at the rate of 25 a minute, which is almost one every two seconds. When operated at top speed the machine might be said to be flying in comparison with hand building, throwing, or casting.

A slightly slower machine, but still very efficient, is the jolley and jigger. The jigger has a revolving head which receives the mold, and the jolley is a pivoted arm which works with a profile template over the jigger. The construction of one of these machines is quite simple and may be undertaken in any small shop. How the jolley and jigger work can be easily seen in Figures 122, 123, and 124. In each case, the dish itself is made on the jigger, while the jolley, holding the profile or

template, does the rest of the work. In some cases the piece constructed is made with the bottom up, while in others the top is up. Accuracy in construction, of course, is essential. The plaster head on the jigger must be removable so that the turned pieces may be removed and set aside to dry while others are being made. For making bowls, soft clay is used; for plates, the clay is stiff and is beaten out with a batter.

Working with a Jolley and Jigger. To work with a jolley and jigger, first construct over the potter's wheel some sort of a jolley which will work easily and yet be comparatively rigid. When the jolley has been made, cut a template to the exact shape of the inside of the piece to be made. By piling soft plaster on the wheel head and then revolving

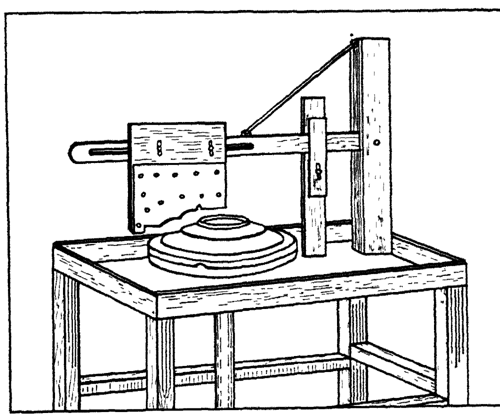


Fig. 122. This homemade jolley and jigger machine will do good work if accurately made, and is within the range of any craft shop. The removable arm is called the jolley and the revolving head, the jigger. Plates are made with the bottom up on this machine.

the wheel, using the template at the same time, a mold can be made for the desired shallow bowl or plate. The wheel head should be removable so that the process can be repeated and as many molds made as are needed for the work.

When the required number of molds is made and dried, construct another template which will fit the molds made but which will now be in the form of the bottom of the dish. Then set the jolley so as to bring the template down to the mold, missing it only by the thickness of the desired dish.

Wedge a lump of clay well and roll out a piece slightly thicker than the dish to be made. Sponge off the mold and press the slab of clay down smoothly and evenly over it. Set the jigger or wheel head spinning and bring the jolley down upon the clay. The profile then will cut the outline of the bottom quickly upon the dish. Use water freely to prevent the template from sticking. Retouch defects and allow the piece to dry until it is stiff enough to be removed, dried, and sanded.

Bowls are made in a similar manner except that the template is brought down inside the mold instead of outside, thus cutting the inner surface of the piece. In this case, too, the molds have to be made from a pattern instead of being cut upon the wheel head with a template. The pattern for the mold, however, can be made on the wheel in the same manner, and this insures the mold's running true to the jolley, when cast from the pattern.

Large pieces of garden pottery, too heavy to be cast successfully, can be made in this way. If very large, they can be pressed and worked into the mold by hand instead of using the jolley and jigger.

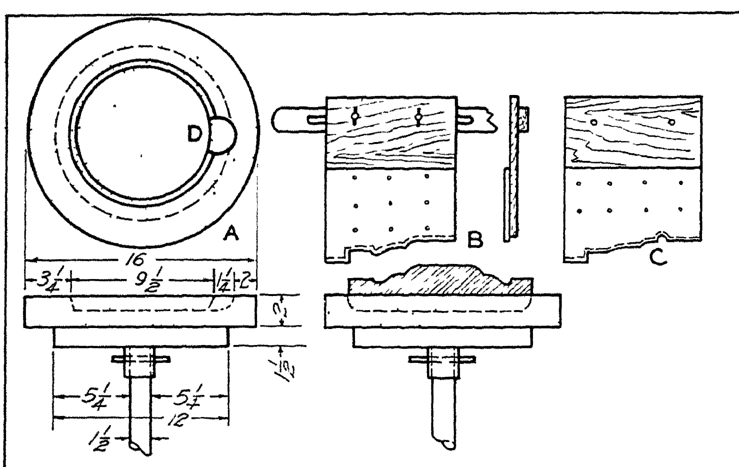


Fig. 123 A wheel head and templates for platemaking. At *A* is the wheel head or jigger ready to hold the plate mold. A template is cut as shown at *B*, and set on the jolley over the wheel head *A*. Plaster then is piled on the wheel head as soon as it is sized, and a form is scraped the exact shape of the inside of the plate. The hatched section is a cross section of this form. The template at *C* then is attached in place of the one at *B*, after which a plate can be made bottom up as shown. A joggle to keep the form from slipping is shown at *D*.

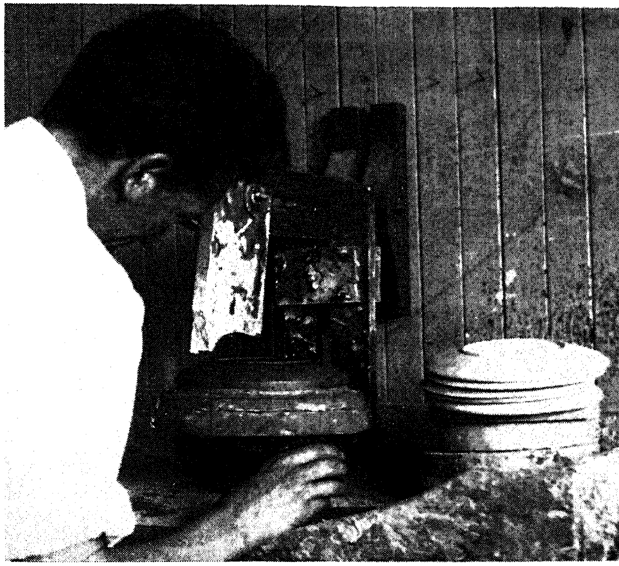


Fig. 124. A homecraftsman making plates on a homemade machine.

Quantity Production. From different government reports some rather interesting data can be obtained on the question of quantity production. In the *Labor Statistics Bulletin* of July, 1926, No. 412, the following figures can be found: A crew of four men averaged 28 doz. plates an hour. For a day of eight hours, that would mean 224 doz., or 2688 plates a day. When one figures that in reality the production day was probably longer than eight hours, one can only wonder at the quantity produced by such a single crew, day after day for many years. The life of a plate must be comparatively short, or the demand for crockery very great.

Similarly, cups were made at the rate of 53 doz. per hour, and saucers at the rate of 42 doz. It is true that this was only the first process and that there was much yet to do, so that many of the original pieces were never finished. However, it is a good example of quantity production in which only a fair quality can be kept as a standard.

Clay Preparation. In digging clay, one again meets the quantity production side and finds it interesting in comparison with the pick-and-shovel process. Huge steam shovels handle tons as easily as an individual does a shovelful, and with little or no waste motion.

Gone, too, is the hand washing and screening, and in its stead have come the pugging mills and large presses.

The kilns cover many acres of ground and hold tons of ware at a time. It is all vast, mammoth in its size, and yet has its place in the complicated processes of life at the present time. But notwithstanding all this, there is still, and always will be, a place in the field for the quiet plodding of the artist, producing the beautiful for the love of art and beauty itself.

Keystone View, N. Y.
Fig. 125. Plates being produced under quantity production methods.

CHAPTER XIV

Biscuit Firing

PROBABLY no phase of pottery making offers greater delight and despair than that of firing. Upon the success of this crucial process hangs the future of every piece. And yet, with care the percentage of broken pieces may be kept very small.

The big problem in firing is to have a steady, uniform heat, increasing slowly from a low temperature to a high one, and through the whole process not to have sudden fluctuations up or down. The first part of the firing must be a slow, soaking heat which drives out all the latent moisture and starts the hardening process. When the kiln begins to glow, the firing can be more rapid, but even then it should not be hurried. The whole process takes time, and it is much better to lean toward a long firing than a short one. In the ordinary portable kiln, seven, eight, or nine hours are none too long for biscuit firing, while in a brick kiln the time may run into several days. The rule is that sudden expansions and contractions must be avoided, if the percentage of broken ware is to be kept down.

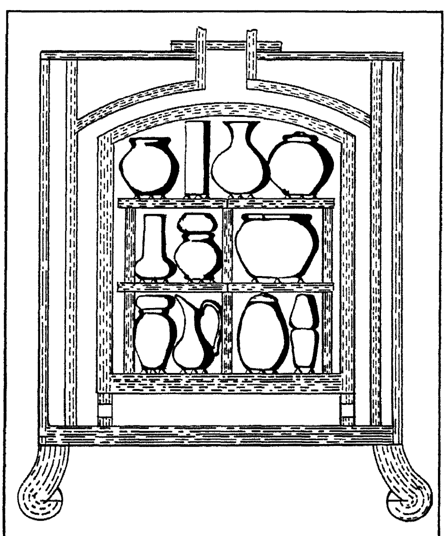


Fig. 128. A cross section of a biscuit-packed kiln. Note how the pieces touch and the lighter ones rest upon the larger. Stilts are used to insure perfect circulation of heat.

Several methods may be followed in the firing of pottery. The most primitive one might

be called the open-fire method. Next to this should be placed the home-built kiln with its improvised muffle or saggers. From the homemade product we come to the commercially made portable kiln, and this is followed lastly by the large factory-built brick type of kiln. Firing by the first three methods will be discussed in detail in the following paragraphs.

The Open Fire. For the student without a kiln, the open or campfire method offers a solution of the problem of firing, but only in part, for only biscuit ware, which is the unglazed product, can be fired in an open fire. And this leaves the problem of glazing still to be solved. Nevertheless, one firing is much better than none, and gives an opportunity to save many pieces which might otherwise be lost. Instead of glazing, it is possible to use many lacquers, paints, and bronzes which give pleasing effects quite similar to those of real glaze.

The process is quite simple. Get an old iron container, strong enough to withstand severe heat and to hold the weight of any wood which may fall upon it. In the bottom of this vessel place a layer of dry sand or dirt several inches thick. Upon this set as many pieces as possible, keeping them well away from the outside walls. Now cover these dishes with more dry sand or dirt and again place a layer of pieces. Keep putting in layers of sand and dishes until the can or kettle is full, at which time it is ready for the firing. Protected as the ware is from sudden fluctuations of heat by the sand, the fire may now be started quite normally around the container. If the improvised kiln is large, set it in a low spot or in a depression scooped out from the ground, so that the fire can gradually be banked in well around it. Keep a steady blaze going all day, finishing off in the evening with a good, heavy fire. Allow the cooling to go on all night and far enough into the next day until the sand is cool and may be easily handled. When all is cool, remove the pieces, dust them off, and paint them to suit the taste of the individual. Aluminum and the bronze paint give especially pleasing effects. Before finishing the ware, however, size it with some convenient medium. Shellac, varnish, or water glass may be used.

If it is impossible to find an old container in which to pack the ware for firing, the ground itself may be used and the pieces may be buried in a pile of sand. Caution must be observed in this case to see that the work is not broken by the weight of the fuel while firing. It is more difficult to have the heat reach the pieces in the center of the pile next

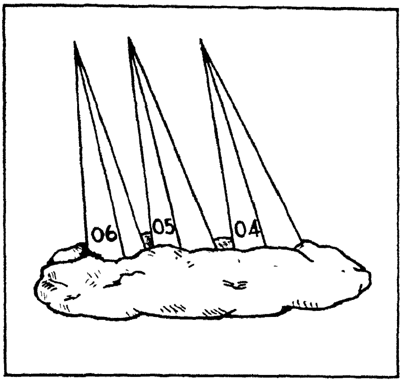


Fig 129. Pyrometric cones before firing. Note that they lean in the direction in which they should fall At the beginning of the firing, cones should be placed in several portions of the kiln to obtain the average temperature Later one set will do.

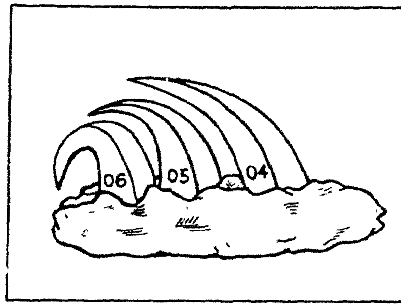


Fig 130 As soon as the last cone has begun to fall, the fires may be drawn and the drafts closed The cooling should be slow and gradual. Always use at least two cones in a group, although three are better To depend on one cone would be courting disaster for, if it should go down without observation, the worker would be in a dilemma

to the ground. In either method, the sand must protect the work from all sudden fluctuations of heat and from every cold draft of wind.

The Home-Built Kiln. If at all possible, it is advisable to use a home-built kiln in place of the campfire. Such a kiln can be made in a simple manner with plain or common brick lined with firebrick, and supported with heavy sheet-iron plates. For fuel, wood, coal, or oil can be used, depending on what is most economical and convenient. Protect the pieces from direct contact with the fire by large clay pots called saggers. Various types of saggers can be built at home for different kinds of work. Plan them so, however, that when stacked in the kiln the bottom of one sagger may form the cover of the one underneath it, so that covers are needed only for the top layers.

These kilns will produce some very satisfactory work, but their heating fluctuates considerably, and unless built by a professional, cause a rather high percentage of broken and defective pieces. The same kiln can be made of the muffle type, instead of with saggers, if the potter is ingenious and has patience enough to study and overcome his problems.

The Portable Commercial Kiln. If the output is comparatively small, the portable commercial kilns will do nicely. They are well built and have a uniform range of heat, so that the percentage of loss in pieces is very light. They are also quite economical of fuel where oil or natural gas can be used. In the larger plants, the portable kiln still

comes into play very conveniently for testing work and for small, special orders.

To Pack a Portable Kiln. In packing any kiln, be sure to use plenty of stilts or supports so that the weight is evenly distributed on the bottom of the pieces, and so that the heat has every opportunity to pass through evenly. It is better to fire the biscuit separate from the gloss, although there is no harm in putting in an occasional glazed

Fig. 131 A muffle-type kiln, biscuit packed, just as the door has been opened for unpacking. It had been heavily packed, but came out very nicely with no breakage.

piece. Remember, however, that all gloss pieces must be at least ½ in. apart instead of resting close together as the biscuit pieces do.

Lighter pieces can be placed on top of heavier ones, though it is not well to carry this plan too far. Glazed tile, if the bottoms are left free

of glaze, can also be safely fired resting as a cover on some of the more sturdy pieces. But in packing a kiln, as in any other work, experience is the thing that eventually makes one efficient. To use all the space most economically, to know where the hot and cold spots are to be found in every kiln, to make and use the right props and shelves, all this comes through trial and learning.

Firing the Portable Kiln. Climatic conditions will affect the firing of a kiln considerably, and so the craftsman or beginner must not be discouraged if it takes longer than he anticipated when he put on the

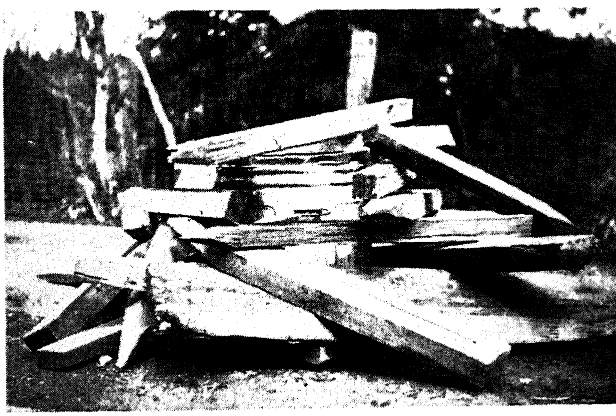


Fig. 132. In this open-fire kiln, pottery was buried deep in the dry sand in the can. Glazing is not practical in this type of kiln but for biscuit work it is very satisfactory.

first heat. Whatever fuel is used, the kiln should be started gradually, so as to dry out the latent moisture in the clay and let expansion take place slowly. An increase in the fuel can be made once an hour at first, and then increased to half-hour periods as the temperature rises. Through it all it is necessary to keep in mind the fact that the steadier and more even the increase, the better the ware, and the less the warpage and breakage. The firing should go on for about eight or nine hours, though it can be done in some kilns in a much shorter time, with an increase accordingly in breakage. It is well to keep all outside doors closed where drafts might affect the burners.

Cooling the Kiln. When the last temperature cone has gone

down, close all the drafts very carefully, lock the door to the kiln room, and allow the kiln to cool very slowly for about 12 or 14 hours. In fact, do not take the pieces from the kiln until they can be very comfortably handled with the bare hands. When the biscuit firing has cooled, take the pieces to the glazing and decorating room preparatory to the final process.

The Metropolitan Museum of Art
American twentieth-century porcelain vase.

CHAPTER XV

Glazes and Glaze Composition

FOR many pottery craftsmen the process of glazing a piece of pottery is more alluring than turning or firing. This is especially true where the worker compounds his own glazes. In fact, half the fascination and charm is gone when the individual buys even the best glazes in ready-made form. To take a formula as a guide, and then to figure, plan, and test it until a dreamed-of glaze has been produced is a real joy only to be found in such work. Then, too, the cost of preparing glazes is much lower than buying them, so that the worker can do much more with the same amount of money. The writer does not mean by this to reflect in any way upon the commercially prepared products. Many of them are fine. Only, the artist who wants to get the fullest thrill out of his work should do all the processes from finding his clay to firing and glazing.

One of the first tests is to find a glaze that will fit the clay at hand, and that is a result that no commercial dealer can guarantee. Around a glost kiln, there will always be an atmosphere of hope and mystery. It is a most interesting study, gripping one with its unending charm.

Function and Composition. Quite often the thin, colored coating on the surface of a piece of pottery is thought of as paint, and the writer has had students say, "I don't want that kind of paint," especially when they were required to apply the glaze with a brush. However, the glaze coating is far from paint and is much more durable. It is really a material composed largely of silicates which form a complicated formula for glass. It has two functions — serviceability and beauty. The glaze must fit the dish so perfectly that there can be no danger of leakage; it should radiate color and life until the beauty of the pieces is greatly enhanced by its application. The glaze and the piece should be

developed in harmony, however, so that the one completes the other and neither is used solely for itself.

Technical Knowledge. Although an understanding of chemistry is helpful, a wide technical knowledge of glazes and their preparation is not entirely necessary for the beginner or the average craftsman. The student needs only to look at past records of the pottery craft to know that much was done to develop fine glazes long before chemistry was even known. The Egyptians, the Greeks, and the Chinese had glazes ages ago, so take courage and try. It is doubtful, too, whether the work can be called an exact science as there are too many unknown or at least uncontrolled factors. The rather complicated formulas, the gases from the clay and fuel, the oxidizing and reducing flames of the glost furnace, all tend to make glazing a more nearly empirical process than a strictly scientific one. Patience, the ability to keep a careful record of what has been done, and the desire to learn will go a long way toward success. Therefore, only common-sense principles of glazing will be given here as a guide to study and experiment. The more complicated data can be found by the advanced worker in technical books.

Composition. Like glass, glazes are compounded from chemicals containing silicates. In the low temperature group, with which this study deals, are lead, zinc, and flint, coupled with feldspar, kaolin, ball clay, and whiting to form the basis for standard glazes. These materials are all insoluble and cannot be dissolved when ground in water. Glazes made from these substances are sometimes called raw glazes, because this insoluble quality makes it unnecessary to prepare the chemicals by further treatment. They are also designated as lead glazes because the oxide of lead serves as the fluxing base.

Fritted glazes, on the other hand, have a chemical composition of such a nature that part of the chemicals have to be prepared by fritting — that is, partially melted — so that they will not dissolve and be washed away in the surplus water.

Depending upon their composition, glazes also may be grouped as gloss or matt and as clear or opaque glazes. Gloss glazes, as the term would indicate, are very brilliant. They are striking and attract attention. They also reflect the shadows and emphasize defects. Matt glazes are softer and have a velvety appearance. They are not as brilliant as the gloss finishes, but they give a feeling of hardness and stability to the ware. Clear glazes are excellent to bring out qualities in the body of the

piece and reveal the underglaze designs. Opaque glazes are made so by the introduction of tin oxide into the clear glaze. The oxide of tin remains a white body in suspension in the glaze and makes possible many light-colored glazes which would be difficult to prepare. Each type of glaze has its place and each can be made by the student in his laboratory.

Fritted glazes open a remarkable field for study for those who wish to take the trouble to prepare them. The borax fluxing base, which takes the place of the white lead in the raw glazes has several points in its favor. It is nonpoisonous and does not, therefore, endanger the worker's health. Its reaction to color is not nearly so severe as other fluxes, which makes possible a much wider color scheme. However, the preparation of a fritted glaze does have its obstacles, as the fritt must be prepared and a fritting furnace is almost a necessity. It is true that a fritt can be melted in an ordinary kiln during the process of firing, but the results, as a whole, are not satisfactory as the mass is hard to break up when taken cold from the kiln. Even under these difficulties, however, it would pay the experimenter to prepare at least one fritted glaze. If the fritt, when melted, can be poured immediately into water, it is then broken up and more easily prepared.

One of the simplest glazes is a salt glaze composed entirely of common table salt. This, when thrown upon the fire at a comparatively high temperature (1200 deg. centigrade), is volatilized and finds its way as vapor into the kiln where it settles on all exposed surfaces. It is not a practical glaze for art pottery as it necessitates a specially built kiln, and is not very attractive. Its practical application is limited to commercial tile and ware of a like value, where waterproofing the surfaces is the most important requirement.

The peasants in some sections of Europe have used galena — lead sulphide — as a simple glaze. Mixed with slip, this substance forms a yellowish coating on the pottery. However, this glazing is not very attractive; it crazes badly, devitrifies, and is not to be recommended for anything but cheap ware.

Chemicals Used. The most common chemicals used in glaze preparation of basic lead glazes are given in a table at the top of page 114.

Any unit of weight may be used with the molecular figures. For convenience the author has used grams in this table.

Table of Chemicals

Common Name	*Chemical Symbol After Firing*	*Combining Molecular Weights*
White lead	PbO	258
Feldspar	$K_2O.Al_2O_3.6SiO_2$	557
Whiting (Calcium carbonate)	CaO	100
Zinc oxide	ZnO	81
China clay (kaolin)		
(Before firing)	$Al_2O_3.2SiO_2.2H_2O$	258
Calcined china clay	$Al_2O_3.2SiO_2$	222
Flint (silica powder)	SiO_2	60
Tin oxide, Stannic oxide	SnO_2	150

The feldspar should be of the orthoclase or potash type, and as there are several kinds of feldspar, the worker should be sure to get the right kind.

The dry white lead can be purchased from local paint dealers, but should be tested for impurities which might upset the glaze. A little whiting would not particularly harm the material for paint, but would damage it as a glaze.

The chemicals listed in the foregoing table are those used for a glaze base. The colors are given in the following table. It is unfortunate that many of the beautiful paints and available pigment colors cannot be used, because the intense heat of firing destroys their beauty, but such is the case. Many of the more common but beautiful colors are lost to the ceramist because in the heat of the kiln they burn completely away or turn to a dull gray.

Table of Colors

Mineral Oxide	*Chemical Symbols*	*Combining Molecular Weights*	*Color Obtained*
Copper oxide	CuO	79	Green
Cobalt oxide	CoO	80	Blue
Iron oxide	Fe_2O_3	160	Light yellow
Manganese carbonate	$MnCO_3$	115	Mulberry and black
Nickle oxide	NiO	75	Gray
Uranium oxide	U_3O_8	842	Orange
Burnt umber			Brown or red brown
Yellow base			Yellow
Orange base			Orange
Pink oxide			Pink and red

Umber is a chemical composed of manganese and iron oxides mined in Cyprus. Calcined or burnt, it is highly prized as a paint pigment, and when used in comparatively large amounts in glazing gives some rich brown shades. It is inclined, however, to cause the glaze to craze, especially when used in large quantities.

A combination of 60 parts of red lead, 40 parts of antimony oxide, and 20 parts of tin oxide, when calcined together and well stirred, will serve as the base for a good yellow. Place the mixture in a tin can and heat over a hot gas flame, stirring steadily until the mass is red hot and well blended. In this combination the more antimony that is used the deeper the yellow which will result, but care must be taken in the use of antimony as there is danger, when too much is added, of producing blisters in the glaze. Venetian red will also give a soft yellow.

Orange is a much harder color to produce. Some have success with Black Uranium oxide, and some with Orange Uranium oxide. The orange base composed of 60 parts of red lead, 40 parts of antimony, and 20 parts of Crocus Martes (red oxide of iron), mixed and calcined the same as the yellow base, gives another type of orange. Both types of orange work well for some workers in some glazes, but are not as reliable as some other colors.

Pink oxide is a patented compound sold by leading ceramic chemical dealers. It is good for pink and red, though the color will burn out rather easily.

All these ingredients should be purchased from reliable dealers, and care should be taken to get the identical grade of each chemical each time. As mentioned previously, the white lead may have impurities in it which are fatal to good results. All of the chemicals should be ground to the same degree of fineness. The flint, for example, always should pass through the 200 mesh, if that is the grade with which the young ceramist has started.

Unfortunately, glaze compounding has to be based largely on tested formulas. In other words, it is somewhat of a mix-and-try process. A glaze worked out carefully on paper still has to stand the test of the kiln. Chemicals, gases, fuels, colors, and clays must all be tested, so that the virtue of patience goes hand in hand with careful study and careful compounding. The worker who wishes to create something worth while should not be discouraged by failures or indifferent successes—careful experiments are the price of success.

Table of Chemicals

Common Name	*Chemical Symbol After Firing*	*Combining Molecular Weights*
White lead	PbO	258
Feldspar	$K_2O.Al_2O_3.6SiO_2$	557
Whiting (Calcium carbonate)	CaO	100
Zinc oxide	ZnO	81
China clay (kaolin)		
(Before firing)	$Al_2O_3.2SiO_2.2H_2O$	258
Calcined china clay	$Al_2O_3.2SiO_2$	222
Flint (silica powder)	SiO_2	60
Tin oxide, Stannic oxide	SnO_2	150

The feldspar should be of the orthoclase or potash type, and as there are several kinds of feldspar, the worker should be sure to get the right kind.

The dry white lead can be purchased from local paint dealers, but should be tested for impurities which might upset the glaze. A little whiting would not particularly harm the material for paint, but would damage it as a glaze.

The chemicals listed in the foregoing table are those used for a glaze base. The colors are given in the following table. It is unfortunate that many of the beautiful paints and available pigment colors cannot be used, because the intense heat of firing destroys their beauty, but such is the case. Many of the more common but beautiful colors are lost to the ceramist because in the heat of the kiln they burn completely away or turn to a dull gray.

Table of Colors

Mineral Oxide	*Chemical Symbols*	*Combining Molecular Weights*	*Color Obtained*
Copper oxide	CuO	79	Green
Cobalt oxide	CoO	80	Blue
Iron oxide	Fe_2O_3	160	Light yellow
Manganese carbonate	$MnCO_3$	115	Mulberry and black
Nickle oxide	NiO	75	Gray
Uranium oxide	U_3O_8	842	Orange
Burnt umber			Brown or red brown
Yellow base			Yellow
Orange base			Orange
Pink oxide			Pink and red

Umber is a chemical composed of manganese and iron oxides mined in Cyprus. Calcined or burnt, it is highly prized as a paint pigment, and when used in comparatively large amounts in glazing gives some rich brown shades. It is inclined, however, to cause the glaze to craze, especially when used in large quantities.

A combination of 60 parts of red lead, 40 parts of antimony oxide, and 20 parts of tin oxide, when calcined together and well stirred, will serve as the base for a good yellow. Place the mixture in a tin can and heat over a hot gas flame, stirring steadily until the mass is red hot and well blended. In this combination the more antimony that is used the deeper the yellow which will result, but care must be taken in the use of antimony as there is danger, when too much is added, of producing blisters in the glaze. Venetian red will also give a soft yellow.

Orange is a much harder color to produce. Some have success with Black Uranium oxide, and some with Orange Uranium oxide. The orange base composed of 60 parts of red lead, 40 parts of antimony, and 20 parts of Crocus Martes (red oxide of iron), mixed and calcined the same as the yellow base, gives another type of orange. Both types of orange work well for some workers in some glazes, but are not as reliable as some other colors.

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To begin with, an analysis of a standard glaze formula might help to make the subject clear. This formula, like others, has been tested, and on some clays found satisfactory.

In any glaze arrangement the chemicals will be found to be grouped according to their functions. In one group will be found the bases or foundation group, those materials which form the fluxing base such as lead, borax, etc., while in another group are the silicas which are the controlling factor in the behavior of the mass as a whole. Joining these two groups is the alumina which acts as a stiffening body and governs the flow of the glaze.

As stated earlier, galena mixed with clay has been used in some cases by the peasantry of Europe, and sufficed to produce certain results when better materials were not available. However, galena glazes left much to be desired. A little better glaze can be made by using white lead, $Pb(OH)_2.2PbCO_3$, which becomes PbO under the influence of heat, and flint, SiO_2, in equal parts. This glaze, however, like the galena, opens a wide field of experiments. It is too fluid, will craze, and is lacking in a number of desirable features. There are three main problems to be faced by anyone preparing a glaze. The glaze must fit the clay, that is, not crack or peel off. It must not only not peel off but must not craze, that is, crack in fine broken lines; and lastly it must have a good texture suiting the design and shape of the piece, leaving no thin spots or rough edges formed by drippings from the bottom.

Temperature. The glazes plotted in this and the following chapters belong to the low-temperature group, as it is felt the greatest number of beginners will be helped by these glazes. Many glazes that will warp and melt at a high temperature will do nicely if the heat is kept down. The fine results obtained in the use of glaze formulas and recipes, that will do well at an average heat, will satisfy most users of this book. The ambitious ceramist who desires to use the higher temperatures should consult books listed on page 187.

The least expensive method of testing glazes is through the use of temperature cones. These cones are patented, chemical compounds, prepared to melt at definite temperatures. They are graduated from a low to a very high temperature, in steps about 30 deg. apart. They come in boxes of 50, and cost in the neighborhood of 1½ cents a piece. Though not as satisfactory as an electric pyrometer, they answer well and are much cheaper.

From a careful study of a glaze formula, a number of interesting points can be learned, and the chemicals placed in various regular groups. To illustrate, a standard glaze formula is given:

	PbO	CaO	ZnO	K_2O	Al_2O_3	SiO_2	SnO_2
Per cent	70	.20		10	15	1.60	

From this formula it will be noted that the first four items belong to the monoxide group, or chemicals with one oxygen atom content; the fifth item to the trioxide, and the last two to the dioxide group.

Monoxide Group

	White lead	*Whiting or calcium carbonate*	*Zinc oxide*	*Feldspar*
	PbO	CaO	ZnO	K_2O
Per cent	.70	.20		.10

Dioxide Group — **Trioxide Group**

	Flint or Silica powder	*Tin oxide Stannic oxide*	*China clay or kaolin*
	SiO_2	SnO_2	Al_2O_3
Per cent	1.60		.15

This shows the oxygen relationship of a glaze and is important in keeping a balance in the formula. To have a definite basis of figuring, and also to keep the chemical balance, it is advisable that the per cents listed in the monoxide group be kept as a basis of unity, or 100 per cent. In fact, the three items given would make a fair glaze though still lacking in several features. It must be remembered, too, that glaze formulating depends on experiment and experience.

Percentages in two items are omitted from the list of this particular formula—ZnO in the monoxide group and SnO_2 in the dioxide group; yet, the glaze formula, as given, will be satisfactory for some clays. But, it will be noted that the glaze compound is growing in the variety of its content, and that we have come a considerable distance from our original white lead and flint. However, the glaze will be found to be improving, as it no longer runs, and in most cases, does not craze or devitrify badly. The materials added have stiffened the mass. Nevertheless, two items still can be added in the way of improvement, and they are the two unrecognized in the formula given, namely, zinc oxide (ZnO) and tin oxide (SnO_2). A little zinc oxide added to the formula will aid in brightening and improving the colors. If the fusing

point is to be kept the same, this should be taken from CaO (calcium oxide), as it must be remembered that the unity of the monoxide group should not be disturbed. We might thus take .15 instead of .20 of CaO and then have .05 for the ZnO. This will improve the glaze and not disturb the chemical balance. But the glaze might still be a problem. When melted it is clear, showing the body of the clay through its surface, and when the colors are added, nearly all will run to the dark tones. To improve this feature of the glaze, a small proportion of tin oxide (SnO_2) is added. This renders the glaze opaque and makes possible a wide range of light colors. The formula would then read:

	PbO	CaO	ZnO	K_2O	Al_2O_3	SiO_2	SnO_2
Per cent	.70	.15	.05	.10	.15	.160	.10

This makes a very satisfactory opaque glaze on most clays maturing about cone 06 to 05. To lower the melting point, the per-cent ratio in the monoxide group needs only to be changed by increasing the lead (PbO) per cent and decreasing the whiting (CaO) proportionally.

Translating a Formula. The empirical formula illustrated, however, represents the oxides only in the per-cent form, and still must be translated into batch weights. As the chemicals given in the formula cannot be weighed in this form, it becomes necessary to calculate the actual amount of the chemicals called for in the glaze.

While some of the commercial substances will furnish a single unit of the formula in a pure state, others will be found to have combined several parts of the formula within themselves, so that when these substances are added, some of the others will need to be reduced accordingly. For example, by looking at the table of chemicals and commercial substances, we find that lead will supply the PbO, and will give us none of the other substances. Likewise, whiting will supply the calcium oxide (CaO). Though feldspar will supply potash (K_2O), it will also supply alumina (Al_2O_3) and silica (SiO_2), feldspar having these chemicals in the proportion 1 K_2O, 1 Al_2O_3, 6 SiO_2. Therefore, .10 K_2O will supply not only .10 K_2O, but also the .10 Al_2O_3 and .60 SiO_2, thus reducing the per cent needed of Al_2O_3 and SiO_2 accordingly. Again, Al_2O_3 will supply not only one unit of alumina but two of SiO_2. To place the formula with this overlapping in a practical form, it is generally well to write out a table showing the additions and subtractions, and give the exact per cents necessary in a clear concise form. It is then

only necessary to multiply this by the molecular weight to get the batch weight to be used in weighing out the glaze.

In the dioxide group, though the SnO_2 (tin oxide) is as a rule an inert mass, there is sometimes difficulty in the balance of the glaze, in which case a better unity can be brought about by reducing proportionately the other dioxide, SiO_2.

Most of the chemicals will run true to form if purchased from a reliable dealer. However, if trouble arises, it is well to test the feldspar (K_2O), the flint (SiO_2), and the tin oxide (SnO_2).

The more the individual studies the various formulas to be found, the more he will see the divergence of the authorities in the percentage of the different chemicals used. This should not discourage the beginner, but rather encourage him to go ahead and compound a glaze, which in the end may be particularly satisfactory. As may be seen in the monoxide group, the combinations are many and varied, the only problem being to keep the total at the point of unity. For example, any of the following combinations will produce results and may be equally satisfactory on different clays, though in each case, the fusing point will be different.

Monoxide Group Combinations

	PbO	CaO	K_2O	ZnO	*Total Per Cent*
Per cent	.70	.20	.10	.00	100
	.70	.15	.10	.05	100
	.80	.10	.05	.05	100
	.70	.10	.15	.05	100
	.60	.15	.10	.15	100
	.70	.10	.10	.10	100
	.60	.25	.10	.05	100
	.65	.15	.10	.10	100

The trioxide group varies considerably, also in practice of the various authorities, but has stabilized itself between .15 and .20. There seems to be a wider variation in the dioxide group, which stabilizes itself around 1.60 to 1.75.

In case a large quantity of SnO_2 is added, it is well to reduce the amount of SiO_2 proportionately.

Working Out the Problem. The first step in the procedure is to place the list of chemicals desired in the formula with their per cents in a vertical line.

Glaze Chart or Problem

Symbols	*Required Per Cent*	—	*Required Per Cent Taken Out*	*Per cent of Each Used in Glaze*	
PbO	.70	—	.70 = .00	PbO	.70
CaO	.15	—	.15 = .00	CaO	.15
ZnO	.05	—	.05 = .00	ZnO	.05
K_2O	.10	—	.10 = .00	K_2O	.10
Al_2O_3	.15	—	.10 = .05 — .05 = 00	Al_2O_3	.05
SiO_2	1.60	—	.60 = 1.00 — .10 = .90 — .90 = .00	SiO_2	.90
SnO_2	.10	—	.10 = .00	SnO_2	.10

NOTE: The subtraction is done to see what chemicals have additions beside the per cent called for. Only two are affected, and those are K_2O and Al_2O_3. In these cases then, only .05 of Al_2O_3 will be needed and .90 of SiO_2. The rest stand as at first.

Table for Batch Weight

Symbols	*Required Per Cent*	*Combining Molecular Weights*	*Batch Weight in Grams*	*Commercial Materials*
PbO	.70	258	180.60	White lead
CaO	.15	100	15.	Whiting
ZnO	.05	81	4.05	Zinc oxide
K_2O	.10	557	55.70	Feldspar
Al_2O_3	.05	258	12.90	Kaolin
SiO_2	.90	60	54.	Flint
SnO_2	.10	150	15.	Tin oxide

It will not be necessary to weigh out these materials in fractional quantities. Where the amount is not even, either the figures next above or below the fraction may be taken. The batch may now be weighed out on any convenient scale. The gram offers a good basis to begin with on the first batch. For trial then take:

	Grams
White lead	181
Whiting	15
Zinc oxide	4
Feldspar	56
Kaolin	13
Flint	54
Tin oxide	15

These materials, when weighed out, ground, and screened through a 100-mesh screen, will produce a well-balanced gloss glaze, maturing between cones 06 and 04. Due to the presence of tin oxide, the glaze will be an opaque, white glaze if applied in any degree of thickness. If, however, a clear glaze is desired, it is only necessary to omit the tin oxide to get that result.

Color for Glaze Batches. There is a vast field for experiment in the coloring of glazes, and many interesting results have been gained through the untiring efforts of the experimenter who is willing to try and try again, until something beautiful results from his work. Here, too, though a wide knowledge of the chemistry of colors is very helpful, yet, the amateur need not be disheartened, for much may be gained through patient work. Whatever the background, however, a careful record should be kept of all trials, and notations made as to the results obtained.

Looking at the table of chemicals used in coloring, the question immediately arises, how much should be used in proportion to the other chemicals in the glaze batch. Cobalt and nickel oxide are strong colorants and should be used sparingly, while yellow base, pink oxide, iron oxide, and burnt umber are mild in their reactions. For cobalt and nickel, about 1 per cent of the total batch weight will be sufficient; in the artificial oxides and burnt umber, 10 per cent is more nearly the right amount. Copper oxide as a colorant acts as an additional flux, lowering the melting point of the batch, while cobalt, manganese, and nickel oxide are rather inclined to raise the fusing point slightly. Manganese carbonate can be used in larger quantities than manganese oxide and will give varying shades from mulberry to a dark purplish black.

Antimony oxide, which is one of three chemicals in the yellow-base compound, must be used with considerable caution, as it is inclined to create blisters when used in too large a proportion. It can also be employed in the place of tin as an opaquing compound, but as a whole is not satisfactory.

Percentage Basis. To be scientifically accurate, many ceramists figure by the oxygen ration group, placing the colors in whatever grouping they come and figuring in the per cents accordingly, instead of by the per cent of the total batch as suggested in the foregoing. For example, cobalt, copper, nickel, and manganese oxides all have an oxygen ratio of one atom content. Therefore, these colors are figured to keep

the monoxide ratio in perfect unity, or 100 per cent. However, as each one of these colorants reacts differently, a great deal of variation and graduation of color can be had by using varying quantities and keeping a careful record of the same.

The Metropolitan Museum of Art
Danish twentieth-century porcelain jar.

CHAPTER XVI

Matt and Fritted Glazes

A STUDY of glaze analysis and composition will naturally encourage the ceramist to attempt the preparation of matt glazes. To most lovers of pottery, matt glazes are very pleasing and their quality grows upon one. There is something very stable and satisfying in the texture of a matt glaze, and to prepare a good recipe affords a great deal of satisfaction. Gloss glazes are brilliant and striking, while matt glazes are soothing and restful. Both types of glazes have distinctly appropriate applications, and each should be made with these applications in mind.

Matt Glazes. The evolving of a matt glaze is no more difficult than that of a finely balanced gloss, and is equally interesting. A matt glaze is most easily made by increasing the quantity of some of the chemicals in the glaze. If the quantity of kaolin (China clay) is increased and the silica (flint) is reduced, a pleasing matt may be obtained. Other chemicals used in excess will at times produce the desired effect. For example, an oversupply of silica will produce a matt, and even tin oxide in large quantities gives a similar type of surface. In fact, there is room for a wide range of experiments for the individual who wishes to produce odd finishes upon the surface of his ware.

To produce an ordinary reliable matt glaze is not too difficult for the average speculative person who wishes only to get results. There is but one main caution which the writer wishes to repeat and that is to buy all chemicals from a reliable firm and purchase the identical materials every time. On one occasion, the writer had to change his chemical firm in the middle of a winter's production, and the new order was guaranteed to be in every respect the same as that of the old firm. In spite of the guarantee, the matt glazes ceased to be matts, and the glosses were distinct disappointments. In fact, considering the small amount of material in the average glaze batch, the compounding of a

glaze must largely be an experimental process which only careful watching and testing will keep perfectly satisfactory. Yet, the very element of chance adds a new zest, for new wonders are likely to be discovered. Some authority has said that we cannot hope with our modern chemicals to get the quality which the primitive races had in their unrefined ores. Be that as it may, there is no reason why the patient worker cannot evolve a glaze which will be entirely satisfactory for his needs.

The Matt Formula. Any of the glaze bases used in the preparation of a gloss glaze can be used in the preparation of a matt glaze. This is true so long as the proportions are adjusted in relation to the desired fusion point. For example, consider the preparation of a matt which has a fusion point within the range of the average low-firing clay, say cones 05–04.

Glaze Chart or Problem

Symbols	*Required Per Cent*	—	*Required Per Cent Taken Out*	*Per Cents Used*	*Chemicals*
PbO	.60	—	.60 = .00	.60	White lead
CaO	.15	—	.15 = .00	.15	Whiting
ZnO	.10	—	.10 = .00	.10	Zinc oxide
K_2O	.15	—	.15 = .00	.15	Feldspar
Al_2O_3	.35	—	.15 = .20 — .20 = .00	.20	Kaolin
SiO_2	1.60	—	.90 = .70 — .40 = .30 — .30 = 00	.30	Flint

Table for Batch Weight

Symbols	*Required Per Cent*	×	*Combining Molecular Weights*	*Batch Weight in Grams*	*Commercial Name*
PbO	.60	×	258	154.80	White lead
CaO	.15	×	100	15.00	Whiting
ZnO	.10	×	81	8.10	Zinc oxide
K_2O	.15	×	557	83.55	Feldspar
Al_2O_3	.20	×	222	44.40	Kaolin (calcined)
SiO_2	.30	×	60	18.00	Flint

NOTE: The kaolin here is calcined and has, thus, a molecular weight of 222.

A study of the glaze chart will reveal that there has been little or no change between this and the gloss formula. The only difference of vital importance is the increased amount of alumina. Here the change is marked as the amount of alumina is more than doubled, and consequently the amount of silica needed is proportionately cut down because the kaolin contains the extra silica. Multiplying these per cents by the molecular weight will give the results in the Table on page 124.

To calcine kaolin, place it in an unglazed dish in the biscuit-firing kiln. The high alumina content of the matt glaze sometimes causes it to be too plastic, so calcining is resorted to in order to overcome this plasticity. In calcining, the equivalent weight changes from 258 to 222. The change in the formula is not entirely necessary and may be tried out to the best satisfaction. It will be noted that tin oxide is not now present in the glaze. Matt glazes are in themselves opaque, so that the oxide of tin is not necessary for this purpose.

Using the gram as a unit of measure, and multiplying the parts by three in order to make a reasonable batch, the final glaze reads:

	Grams
White lead	464.40
Whiting	45.00
Zinc oxide	24.30
Feldspar	250.65
Calcined kaolin	133.20
Flint (silica powder)	54.00

This, when ground and put through a 100-mesh screen, and applied very evenly, will make a very pleasing silky-white glaze of a matt texture, maturing at cones 06 and 05.

Matt glazes are more pleasing than gloss glazes, but they must be applied much more carefully. They should be mixed, ground, and screened very carefully, and then applied with much skill if the best results are to be gained. They should not be excessively thick nor very thin, and they must be applied evenly, as defects do not correct themselves. Scratches, lumps, and fingerprints are usually indelibly fixed in the firing. If care is exercised, there is no glaze which will better repay the individual for his hours of labor.

Fritted Glazes. Due to the fact that the oxide of lead is poisonous, care always must be taken in its use. With children this is particularly true, so that at times it is quite desirable to prepare a glaze which does

not contain this undesirable material. It is for such a demand that fritted glazes answer a need. Fritted glazes are easier on colors than the lead glazes, so a greater range may be had. Borax is a good medium for color and has a moderately low-firing point, and if it were not soluble in water, it would be a wonderful aid to the ceramist. Even at that, some artists are successful in using it without fritting, by preparing, grinding dry, mixing with only enough liquid for use, and then applying immediately. Mr. George J. Cox of Columbia University is successful in the use of this formula, and his book is to be recommended.[1]

A fritt is a compound of glass, and is used to change soluble substances into insoluble ones. Glazes are ground in water and this fact ordinarily renders the use of any soluble substance impractical in their preparation.

In order to use a number of good substances for the preparation of a glaze, some change has to be brought about to overcome their soluble nature. This change is gained by making a fritt of the desired materials. The fritting alters the mass from a partially soluble one to an insoluble glass. This in turn can be weighed, ground, and made into a practical glaze.

Usually the fritt is not allowed to make a perfect glass, but while in a molten state it is poured into water which cools the mass into a crumbling compound that is much easier to grind than the glass would be. If large quantities of fritted glaze are needed, it would be well to buy a regular fritting furnace. However, for trial purposes, some method can usually be planned which will give the desired results.

If no other means is at hand, the fritt can be melted in an unglazed dish in the regular kiln. Of course, the mass comes out cold with the unpacking and must be broken up with a hammer. This makes the process much harder and more wasteful than with a fritting furnace, but is all right for an experiment. To break this up still more, the glass can be heated over a gas flame and then thrown into cold water which will crack it up some for grinding in the ball mill.

Fritted glazes are nonpoisonous, and solve a number of problems where the handling of large quantities of lead oxide might prove difficult.

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[1] *Pottery*, by George J. Cox. The Macmillan Co., New York, N. Y.

Following are some examples of fritted glazes. The fritt formula is given first and following that is the combined glaze mixture.[2]

Fritt I	Cone 018 (710 deg. centigrade) *Grams*
Refined borax crystals	100
Calcined flint	80
Whiting	40
Soda Ash	20
Cornish China clay	40

NOTE: Crush and screen each ingredient separately. Weigh the batch, mix thoroughly, and screen again. Melt to a glossy fritt in a crucible, and pour into water while still molten. Drain off the water, crush and grind the residue.

Fritt II	Cones .013 to .012 (855 deg. centigrade) *Grams*
Refined borax crystals	120
Ground silica rock	80
Whiting	40
Cornish China clay	30
Soda ash	20

NOTE: Treat this fritt as described in the note for Fritt I.

Fritt III	*Grams*
Refined borax	360
Cornish China clay	720
Calcined flint	180

NOTE: Melt in a fritt kiln at the highest possible heat.

Fritted Glazes

Colorless Glaze I	Cone .010 (900 deg. centigrade) *Grams*
Colorless fritt I	200
Cornish China clay	20

NOTE: For thin dipping, grind in water. If very thick work is required, grind dry and add water.

[2] Courtesy of Henry Carey Baird & Company, Inc., New York, publishers of W. J. Furnival's *Leadless Decorative Tile and Faience Mosaic.* NOTE: This is a most excellent book, unfortunately out of print, and available only in larger libraries.

Colorless Glaze II	*Grams*
Colorless fritt II	100
Calcined alumina	5

NOTE: Grind as in I.

Amber-Tinted Glaze	*Grams*
Colorless glaze I	160
Calcined alumina	10
Ironstone	10
Common manganese ore	5
Uranium oxide, yellow	2½

Golden-Brown Tinted Glaze	*Grams*
Colorless glaze I	160
Calcined ironstone	15
Common manganese ore	5

Moss-Green Glaze	*Grams*
Colorless fritt I	160
Calcined alumina	10
Red oxide of iron	12
Black oxide of copper	12

Royal-Blue Glaze	*Grams*
Colorless fritt I	160
Calcined alumina	10
Black oxide of cobalt	3

Fritted-Matt Glaze	*Grams*
Colorless fritt III	42
Rutilite	12
Ball clay	6
China stone	2
China clay	2

NOTE: Grind carefully together, and apply thickly to the surface of the piece. This will take a higher temperature than the others.

CHAPTER XVII

Recipes for the Potter

IN COMPILING a collection of recipes there is one main difficulty, and that is that there is no method whereby the glazes recommended can be guaranteed to fit every clay. In fact, in some cases, there are clays for which no perfect glaze can be found, so that the best which can be done is to offer a suggestive line of study. The following recipes have all been well tried, and have been found satisfactory under ordinary conditions, and it is hoped that they will be of aid to others, or at least will be of aid in helping to prepare correct formulas. It is in the spirit of service that this book is written.

In order to review once more the methods whereby a glaze can be formulated, still another chart has been given, hoping to make the work clearer by such a process. The main advantage of these charts is to clearly show which chemicals have a carry-over into other groups so that not as much is needed as would be expected in the following groups. This point was discussed in the chapter on Glazes and should be gone over until it is clearly in mind.

Glaze Chart or Problem

Symbols	*Required Per Cent*	—	*Required Per Cent Taken Out*	*Per Cent Used in Glaze*	
PbO	.70	—	.70 = .00	PbO	.70
CaO	.15	—	.15 = .00	CaO	.15
ZnO	.05	—	.05 = .00	ZnO	.05
K_2O	.10	—	.10 = .00	K_2O	.10
Al_2O_3	.20	—	.10 = .10 — .10 = .00	Al_2O_3	.10
SiO_2	1.60	—	.60 = 1.00 — .20 = .80 — .80 = .00	SiO_2	.80
SnO_2	.08	—	.08 = .00	SnO_2	.08

Remember, in order to understand these charts, that K_2O supplies not only one unit of potash but one of Al_2O_3 and six SiO_2; thus the subtraction of .10 of K_2O, .10 of Al_2O_3, and .60 of SiO_2. Also that Al_2O_3 supplies one unit of alumina and two of silica, SiO_2, so that .10 of Al_2O_3 is taken out and .20 of SiO_2. That leaves only .10 of Al_2O_3 to be supplied instead of .20, and .80 of SiO_2, instead of 1.60.

This, when translated into the commercial substances, gave the following recipe:

Table for Batch Weight

Symbols	*Required Per Cent*	*Combining Molecular Weights*	*Batch Weight in Grams*	*Commercial Materials*
PbO	.70	258	180.60	White lead
CaO	.15	100	15.	Whiting
ZnO	.05	81	4.05	Zinc oxide
K_2O	.10	557	55.7	Feldspar
Al_2O_3	.10	258	25 80	China clay
SiO_2	.80	60	48 00	Flint
SnO_2	.08	150	12.00	Tin oxide

When weighed out and tried with the chemicals at hand, the glaze proved to have too much kaolin for a gloss glaze. When the kaolin was cut down, the glaze crazed so that more flint was added to balance the trouble. The formula finally read as follows:

Glaze Chart or Problem

Symbols	*Required Per Cent*	—	*Required Per Cent Taken Out*	*Per Cent Used in Glaze*	
PbO	.70	—	.70 = .00	PbO	.70
CaO	.15	—	.15 = .00	CaO	.15
ZnO	.05	—	.05 = .00	ZnO	.05
K_2O	.10	—	.10 = .00	K_2O	.10
Al_2O_3	.15	—	.10 = .05 — .05 = .00	Al_2O_3	.05
SiO_2	2.20	—	.60 = 1.60 — .10 = 1.50 — 1.50 = 00	SiO_2	1.50
SnO_2	.08	—	.08 = .00	SnO_2	.08

These per cents, when figured into batch weights, made a better recipe which was more satisfactory than the first.

Glaze Chart or Problem

Symbols	*Required Per Cent*	×	*Combining Molecular Weight*	*Batch Weight in Grams*	*Commercial Materials*
PbO	.70	×	258	180.60	White lead
CaO	.15	×	100	15.00	Whiting
ZnO	.05	×	81	4.05	Zinc oxide
K_2O	.10	×	557	55.70	Feldspar
Al_2O_3	.05	×	258	12.90	Kaolin
SiO_2	1.50	×	60	90.00	Flint
SnO_2	.08	×	150	12.00	Tin oxide

This proved to be a much more satisfactory glaze, well balanced and fitting the clay nicely. But in this glaze one item is lacking, and that is color. If fired, it would be white owing to the presence of the tin oxide. We shall, therefore, once more figure the formula, deducting the color per cent from the white lead as this color belongs to the monoxide group. Copper also acts as a flux and will soften the glaze. The glaze, when now fired, should be a deep-green gloss, and might be called "sea green."

Table for Batch Weight

Symbols	*Required Per Cent*	×	*Combining Molecular Weight*	*Batch Weight in Grams*	*Commercial Materials*
CuO	.10	×	79	7.90	Copper oxide
PbO	.60	×	258	154.80	White lead
CaO	.15	×	100	15.00	Whiting
ZnO	.05	×	81	4.05	Zinc oxide
K_2O	.10	×	557	55.70	Feldspar
Al_2O_3	.05	×	258	12.90	Kaolin
SiO_2	1.50	×	60	90.00	Flint
SnO_2	.80	×	150	12.00	Tin oxide

Instead of grams, any unit of measure could be used. However, the grams make a convenient quantity for experimental use. If this formula proves satisfactory on the clay at hand, it is only necessary to multiply the quantity by two, three, four, or whatever number is necessary to make the quantity desired. For a small shop the amounts doubled make a convenient batch with which to glaze several pieces. The recipe will then read:

Sea-Green Gloss

(Cones 05 to 04)

	Grams
Copper oxide	15.80
White lead	309.60
Whiting	30.00
Zinc oxide	8.10
Feldspar	111.40
Kaolin	25.80
Flint	180.00
Tin oxide	24.00

Another glaze, given the author through the courtesy of a friend,[1] is a most excellent glaze and can be highly recommended:

			Grams
PbO	White lead	$.60 \times 258 =$	155.00
CaO	Whiting	$.10 \times 100 =$	10.00
ZnO	Zinc oxide	$.20 \times 81 =$	16.20
K_2O	Feldspar	$.10 \times 557 =$	55.70
Al_2O_3	Kaolin (calcined)	$.05 \times 222 =$	11.10
SiO_2	Flint	$1.66 \times 60 =$	99.60

Multiplied by two we have:

Clear Gloss

(Cones 05 to 04)

	Grams
White lead	310
Whiting	20
Zinc oxide	32
Feldspar	112
Calcined kaolin	22
Flint	200

This formula is not so different from the previous one, but does have a few minor changes. For example, there is a much greater quantity of zinc oxide. This is intended to aid glaze making by improving the color and brightening the glaze. Another point of difference is in the kaolin, which in this formula is calcined. Some feel that plain kaolin makes a glaze that is too plastic, causing it to crack. To overcome this fault, the kaolin is first put in the kiln in an unglazed container, and fired along with the biscuit firing. The heat in the process drives off the latent

[1] The California Faience Company, Berkeley, Calif.

moisture and changes the equivalent weight from 258 to 222. This glaze, however, will work either way, and may be left to the judgment of the user.

There is no color in this batch as it reads in the foregoing formula; it is also a clear glaze since the tin oxide has been left out. In this state it is an excellent glaze to use on the bottom of pieces of pottery and on ware where the body is to show through the glaze. However, it may be easily changed to an opaque glaze by adding twenty grams of tin oxide. It will then read:

White Gloss

(Cones 05 to 04)

	Grams
White lead	310
Whiting	20
Feldspar	112
Zinc oxide	32
Calcined kaolin	22
Flint (silica powder)	180
Tin oxide	20

The best results for a glossy white are obtained when this glaze is applied to a white body, since the white is not dense enough for a red firing body. A good deal more tin oxide may be added, but the brilliance of the gloss will be cut down to some extent.

In the first batch of glaze, the addition of color was figured on a percentage basis, and from an exact chemical viewpoint that method is correct. However, such a system is not entirely necessary and does add considerably to the difficulty of the shop problems. Often the worker wishes to weigh out a number of batches in different colors, and when time is limited, it is a great help not to have to weigh out each batch separately. The glaze will, therefore, be divided into two divisions: the base, which is the same in the whole group, and the color, which is added separately afterward. In this way, ten or twelve glaze batches may be weighed at one time with a great saving of labor. For example, instead of weighing one batch of lead, while the 310-gram weights are on the scales for white lead, ten batches are weighed. After the bases are all complete, the colors can then be added. In cases where tin is not needed, as in black and brown gloss, the tin must be omitted from the glaze base.

A glaze recipe, therefore, can be nicely written out as follows:

Light-Blue Gloss
(Cones 05 to 04)

	Grams
White lead	310
Whiting	20
Feldspar	112
Zinc oxide	32
Calcined kaolin	22
Flint	180
Tin oxide	20

Color for Above

	Grams
Cobalt oxide	3
Iron oxide	2

Royal Blue
(Cones 05 to 04)

	Grams
White lead	310
Whiting	20
Feldspar	112
Zinc oxide	32
Calcined kaolin	22
Flint	180
Tin oxide	20

Color for Above

	Grams
Cobalt oxide	5
Iron oxide	1

By following this system and using either of the two previous glaze recipes, an interesting color scheme can be worked out.

The following combinations are suggestive:

Dove-Gray Gloss

	Grams
Nickel oxide	2

Pea-Green Gloss

	Grams
Copper oxide	5
Iron oxide	2

Robin's-Egg Blue

	Grams
Copper oxide	2
Iron oxide	1

Mulberry Gloss

	Grams
Manganese carbonate	12

Black Gloss

Omit the tin oxide from the glaze base and add:

	Grams
Cobalt	7
Nickel oxide	4
Iron oxide	10
Manganese carbonate	10

Chocolate-Brown Gloss

Omit tin oxide from glaze base and add:

	Grams
Burnt umber	40

Lemon-Yellow Gloss

With or without tin oxide in base.

	Grams
Yellow base	40

Deep-Yellow Gloss

Without tin oxide in base.

	Grams
Yellow base	60

Purple-Black Gloss

Omit tin oxide from base and add:

	Grams
Manganese carbonate	40

Sea-Green Gloss

	Grams
Copper oxide	15

Olive-Green Gloss

	Grams
Copper oxide	12
Cobalt oxide	2

Dark-Green Gloss

	Grams
Copper oxide	12
Nickel	3

Old-Rose Gloss

	Grams
Pink oxide	50

Dark-Red Gloss

Omit the tin from the glaze base and add:

	Grams
Pink oxide	60

Pink oxide is a patented compound prepared from chromium, and can be purchased from any reliable dealer in ceramic supplies.

The use of cobalt sulphate will result in a blue quite different from the blue made with cobalt oxide, and may be used to give variety to the color scheme in the worker's list of glazes. It is soluble and must, therefore, be added to the glaze base after the grinding is done and the water drained off. Dissolve the cobalt sulphate in a small quantity of water and stir into the glaze when the base is quite thick. Stir the batch thoroughly so as to mix the color in well.

For a Moderately Dark Varied Blue Gloss

Add 10 grams of cobalt sulphate.

Yellow is usually prepared from a calcined compound instead of from a single mineral. It is true that a quantity of iron oxide will give a type of yellow, and also the chromium-yellow ocher will give another, but as a rule yellow is produced from a compound called yellow base. For this base a good proportion is:

	Parts
Red lead	30
Antimony	20
Tin oxide	10

This mixture is placed in a tin can over a good gas flame and stirred thoroughly until it turns a dull, even yellow. It is then set aside until cool when it is ready for use. As a rule from 40 to 50 grams is enough for the glaze bases which have been given thus far. For a deeper yellow, the antimony oxide may be increased. However, care must be taken in the use of antimony oxide as too much will cause glazes to blister.

For an orange compound the following may be tried:

	Parts
Litharge (yellow lead)	60
Antimony oxide	40
Crocus martis (red oxide of iron)	20

If litharge proves unsatisfactory, try red lead.

Calcine the mixture in a tin can until the mass is a dark brown. If the chemicals are all carefully chosen, this will prove fairly satisfactory. A common orange compound will result. However, the exact, desired color is not always produced. The orange compound can be used in the glaze base in about the same proportions as the yellow.

Another source for orange which is highly recommended is black or orange uranium oxide. This material under some conditions will produce a good orange of any shade desired, depending on the quantity used.

Rich Brown

To produce a rich brown, 50 grams of burnt umber is added to a glaze base and used without the tin oxide.

To the list of colors may be added a still wider range by combining the oxides in various ratios. For example, copper oxide gives a base for green to which small quantities of iron oxide may be added for one shade, nickel oxide for another, cobalt oxide for another, and so on with almost endless variations. Then one may start with cobalt for a blue, and again produce a wide range of shades through various combinations. It thus may be seen that the thoughtful worker has a wide field in which to work. One of the most convenient aids is a small electric furnace, just big enough for very small pieces, through which many samples may be run in a hurry.

In combining the glazes on the pieces, the dove-gray gloss takes many other colors especially well. These colors may be added as a spill or blend. Mulberry is exceptionally effective as a spill on this gray.

With dark brown, a spill or blend of green is very pleasing, and even the royal-blue gloss may be combined with this color. The brown also may be very effectively blended with yellow.

A professional friend has provided a very interesting glaze which is offered for its very pleasing effect.[2]

	Grams
White lead	25
Ground glass	50
Tin oxide	10
China clay	15

Grind these materials 30 minutes, and put them through a 60- or 80-mesh screen. This is a semimatt glaze which will fire at a cone 05 to 04, according to the glass used. If used without the tin oxide as a clear glaze, a small amount of zinc oxide should be used. The glaze may be colored with oxides or glaze stains. The glass should be heated and broken up in water so that it may be ground easily.

Still another very simple but satisfactory glaze base[3] for both fired and unfired ware is as follows:

	Grams
White lead	420
Cornwall stone	140
Flint	140
Tin oxide	35

This will make an opaque white gloss. For green, add 15 grams of copper oxide.

Another interesting glaze was sent me by a friend.[4] She says: "Every piece is differently marked, and under different heat conditions the color changes. At first the glaze fogged in the dampness here, but lately we have fired it more slowly and longer and that seems to have taken care of the trouble."

The recipe for this glaze is given at the top of page 138.

It may be well to note at this point that most commercial-glaze stains and underglaze colors may be used for coloring glazes. The glazes given thus far are primarily planned to be used on fired or biscuit pot-

[2] H. F. Steinbrunn, Metal Crafts and Pottery Studio, Palo Alto, Calif. Mr. Steinbrunn says: "I sometimes use 30 to 50 parts of the same glaze, mixing it with underglaze colors and then using it as an overglaze for decoration on the same formula. This decorating can also be done on tin glazes by using underglaze colors and grinding them with 30 to 50 parts of clear glaze and using it as an overglaze decoration at the one firing."

[3] Courtesy of W. V. Bragdon, California Faience Co., Berkeley, Calif.

[4] Mrs. Agnes R. Currie, Pottery Studio, Route 2, Box 346, Auburn, Wash.

Cone 08	*Grams*
White lead	69
Feldspar	8
Zinc oxide	3
Ball clay	4
Flint	15
Uranium oxide	20

Use orange uranium rather than yellow.

tery, rather than on the green shapes. They also have a moderately high melting point and are so balanced as not to run badly if overfired. However, at times, a softer glaze is wanted which will not take as much heat and also one which will fit the unfired pieces at times. For such a purpose the following recipe, built up entirely on the cut-and-try method, is quite satisfactory. In applying it to the unfired pottery, care must be taken not to crack the ware by too rapid absorption of the water.

	Grams
White lead	560
Feldspar	32
China clay	48
Flint	160

This will make a very easy-flowing, clear glaze, maturing at cones 07 to 06. To make it opaque, add about 30 grams of tin oxide. Any of the color combinations suggested may be used with this glaze, which has a brilliant gloss but runs badly.

Other friends[1] have permitted the publication of the following glaze recipes which are very good:

	Cone 010 *Grams*	Cone 05 *Grams*
White lead	70	51
Feldspar	7	15
Flint	10	17
Whiting	5	6
Zinc oxide	2	4
Ball clay	6	2
	100	100

Five per cent of barium carbonate can often be substituted with good effect for an equal amount of whiting. The foregoing gloss glazes can be changed to matt glazes by reducing the flint and adding calcined China

[1] Courtesy of Hewitt Wilson, Head of the Department of Ceramic Engineering, University of Washington, and The Denver Fire Clay Company, Denver, Colo.

clay in its place, in amounts up to 15 and sometimes even 20 per cent.

Following are several other recipes which may be tried and adopted if they prove satisfactory:

Semigloss Enamel

(Cones 06, 05, to 04)

	Grams
White lead	180
Whiting	20
Zinc oxide	40
Feldspar	100
Kaolin	40
Flint	20
Tin oxide	60
If color is desired, try	
Copper oxide	12

This is another recipe somewhat like the preceding one, which, if one cares for an odd effect, may give a pleasing result.

Robin's-Egg Blue Gloss

(Cones 06 to 05)

	Grams
White lead	346
Whiting	30
Feldspar	112
Zinc oxide	10
Kaolin	26
Flint	170
Tin oxide	30

Color for Above

	Grams
Copper oxide	4
Iron oxide	1

Pea-Green Gloss

(Cones 06 to 05)

White lead	338
Whiting	10
Feldspar	55
Zinc oxide	8
Kaolin	25
Flint	102
Tin oxide	20

Color for Above

	Grams
Copper oxide	5
Iron oxide	2

MATT RECIPES

Ivory Matt

(Cones 05 to 04)

	Grams
White lead	309.60
Whiting	30.00
Zinc oxide	16.20
Feldspar	167.10
Kaolin	88.80
Flint	36.00

Matt glazes, when no color is added, have a soft ivory finish.

Mullen-Green Matt

(Cones 05 to 04)

	Grams
White lead	387
Whiting	60
Zinc oxide	36
Feldspar	252
Calcined kaolin	132
Flint	54

Color for Above

	Grams
Copper oxide	6
Nickel oxide	6
Iron oxide	6

Yellow-Green Matt[6]

	Grams
White lead	369
Whiting	67
Zinc oxide	36
Feldspar	252
Calcined kaolin	132
Flint	54

Color for Above

	Grams
Copper oxide	15
Iron oxide	12
Nickel oxide	3

Light-Blue Matt

(Cone 05 hard)

	Grams
White lead	348
Whiting	54
Zinc oxide	27
Feldspar	236
Calcined kaolin	123
Flint	50

Color for Above

	Grams
Cobalt	2
Copper	5
Nickel	2

However, as in the case of the gloss glazes, one glaze base may be used for many color combinations and time may be saved in the process by weighing out a number of batches of the same base at one time.

There is also a wide range for color combinations through the variation of the quantity of one oxide with another. Following is given a suggested list of colors to be used.

[6] Courtesy, The California Faience Co., Berkeley, Calif.

Dark Blue

	Grams
Cobalt oxide	5
Copper oxide	12
Nickel oxide	2

Slate Blue

	Grams
Cobalt oxide	6
Nickel oxide	3

Delft Blue

	Grams
Cobalt oxide	5½
Nickel oxide	1½

Blue Green

	Grams
Cobalt oxide	2
Copper oxide	12
Nickel oxide	2

Red or Rose

	Grams
Pink oxide	50 to 60

Steel Gray

	Grams
Cobalt oxide	5
Copper oxide	12
Nickel oxide	2
Manganese oxide	10

Russet Brown

	Grams
Iron oxide	30
Manganese oxide	4

Mulberry Brown

	Grams
Iron oxide	15
Manganese oxide	10

Cool Green

	Grams
Copper oxide	8
Cobalt oxide	1
Nickel oxide	2

Yellow

	Grams
Iron oxide	10

Yellow

	Grams
Yellow base	40

Black

	Grams
Cobalt oxide	5
Nickel oxide	3
Iron oxide	10
Manganese carbonate	10

Royal Blue

	Grams
Cobalt oxide	5
Iron oxide	2

Ocean Green

	Grams
Copper oxide	12

The foregoing recipes should be ample for the beginner and enable him to work out many colors.

The Ternary System. The ternary system of glaze investigation is conducted on a triangle basis, and offers possibilities for a large number of blends or distinct glazes compounded from three basic formulas. The three basic glazes, Nos. 1, 9, and 45, introduce three important ingredients or forms of the glaze-compound feldspar, lime, and lead.

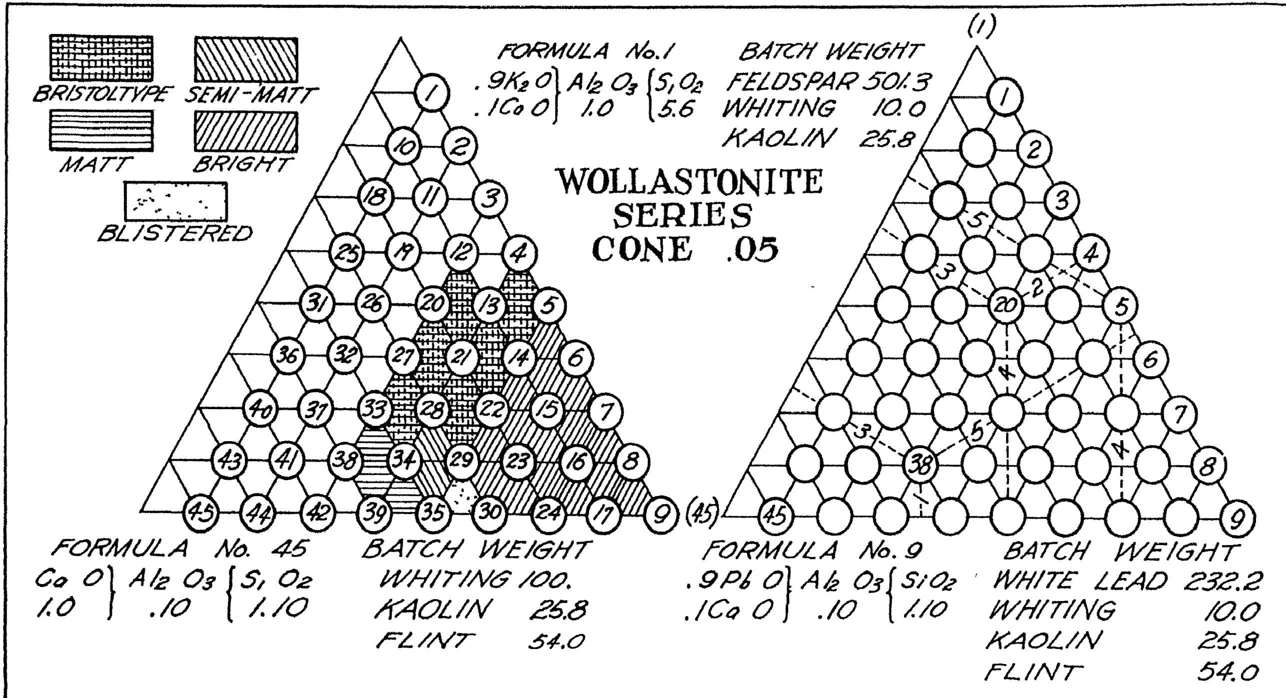

Fig. 135. The Wollastonite chart gives an excellent basis for glaze study. To read, count the number of points or triangles over from the bases in straight lines. The result obtained is the amount of glaze needed from the apex opposite the base used. This chart is an adaptation from the first of a series of four charts by W. G. Whitford, published in the *Industrial Arts Magazine*, October, 1917.

Glaze No. 1 introduces orthoclase, potash feldspar; No. 45, the lime or Wallastonite, made from one formula weight of whiting and one formula weight of flint; and No. 9, the lead or lead meta silicate, made from one equivalent (1/3 formula weight) of white lead and one formula weight of flint. Owing to the difficulty of floating glazes containing no clay, 1/10 formula weight of anothite (made from one formula weight of North Carolina kaolin and one formula weight of whiting) was incorporated into each of the three glazes.

Formula No. 1

$$\left.\begin{matrix} .9 & K_2O \\ .1 & CaO \end{matrix}\right\} \begin{matrix} Al_2O_3 \\ 1.0 \end{matrix} \Big\} \begin{matrix} SiO_2 \\ 5.6 \end{matrix}$$

Batch Weight

	Grams
Feldspar	501.3
Whiting	10.0
Kaolin	25.8
	537.1

Formula No. 9

$$\left.\begin{matrix} .9 & PbO \\ .1 & CaO \end{matrix}\right\} \begin{matrix} Al_2O_3 \\ .10 \end{matrix} \Big\} \begin{matrix} SiO_2 \\ 1.1 \end{matrix}$$

Batch Weight

	Grams
White lead	232.2
Whiting	10.0
Kaolin	25.8
Flint	54.0
	322.0

Formula No. 45

$$\left.\begin{matrix} CaO \\ 1.0 \end{matrix}\right\} \begin{matrix} Al_2O_3 \\ .10 \end{matrix} \Big\} \begin{matrix} SiO_2 \\ 1.1 \end{matrix}$$

Batch Weight

	Grams
Whiting	100.0
Kaolin	25.8
Flint	54.0
	179.8

These basic glazes were ground thoroughly in a ball mill and blended upon the basis of ninths. Glaze No. 20 has a composition of 2/9 of No. 45, 4/9 of No. 1, and 3/9 of No. 9. Glaze No. 5 is composed of 4/9 of No. 1, and 5/9 of No. 9. Glaze No. 38 has 1/9 of No. 1, 5/9 of No. 45, and 3/9 of No. 9. By studying these examples on the chart given, the rules for finding any of the glazes can be understood. The method of location is as follows: Count the distance in points or triangles from the sides of the triangle to the particular glaze desired. The number of points in perpendicular distance away from these sides is the composition of the glaze opposite the given side.

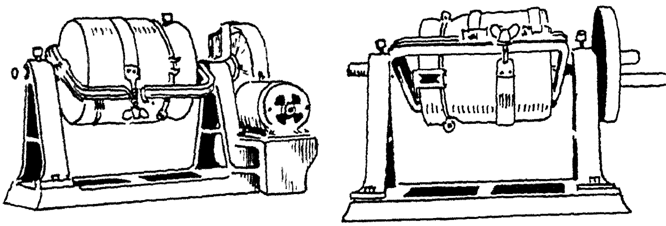

Fig. 136 A ball mill is almost indispensable for a homecraftsman who wishes to prepare his own glazes. A capacity of 1 oz to 5 lb is good for the average small shop It should be run by a small motor, and should turn very slowly

The blending of these glazes can be done either dry or wet, but the basic glazes, after being round, must be dried and proportionate amounts weighed dry to get the correct ninths or parts. The resulting mixture should be again thoroughly ground, adding enough water to bring the mass to a creamy condition.[7] The results which can be obtained from this study are well worth while, and are to be recommended to any individual who enjoys research. The chart given is for temperature cone 05. By increasing the heat up to cones 3 and 4 the entire field can be plotted.

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[7] W. G. Whitford, "A Study of Glaze Composition," *Industrial Arts and Vocational Education.* Courtesy of the Bruce Publishing Company, October, 1917

CHAPTER XVIII

Glazing and Glost Firing

POTTERY may be glazed either before or after it has been fired, the time depending largely upon the nature of the ware, the glaze used, and the results desired.

Glazing Unfired Pottery. Glazing unfired pottery is fraught with many difficulties and does not appeal to the average beginner. However, such glazing can be done, and for some types of ware is very convenient. As with all kinds of pottery, first be sure that the glaze is suited to the clay and will fit the piece when fired. The problem then arises of applying the glaze in such a manner as to avoid cracking the dry clay, and lastly, of firing carefully enough to obtain a ware with a sharp, clear resonance. The field is open for a great deal of experimentation, and each craftsman must work out the methods best suited to his needs.

Glazing Biscuit Ware. From the chapters on glazes, choose a good glaze recipe and weigh it out ready for use. Grind and screen the lot, using plenty of water and a 100-mesh screen.

Prepare, too, a batch of gum tragacanth by soaking an ounce of the gum in one quart of water overnight and then beating it thoroughly with a good rotary egg beater. Add a second quart of water and let the mass stand again for several hours, after which it should be beaten to a thick, creamy state.

Drain all the surplus water from the glaze previously ground, and add 4 oz. of the gum tragacanth to the batch. The gum will give body to the glaze, and keep it from crumbling from the dish when the piece is packed in the kiln. The glaze should be of a thick, heavy consistency, almost like cake batter.

Application of the Glaze. Glazing is an interesting process. The material may be applied in various ways. The pieces may be dipped,

sprayed, or painted with a brush, or the glaze may be carefully poured over the pieces. Each method has its advantages and its disadvantages. Dipping is an excellent method but necessitates large quantities of glaze, with corresponding large containers; it is a method which leaves the small producer at a disadvantage where a wide range of colors is used.

Pouring comes to the aid of the individual whose work is done on a small basis, as the glaze can be handled in little batches and containers. Spraying can be done by anyone who has the equipment and wishes to try it out. Provision, however, should be made to save the glaze, so easily wasted by this method, and care should be taken to avoid inhaling any of the mist, as lead oxide is poisonous.

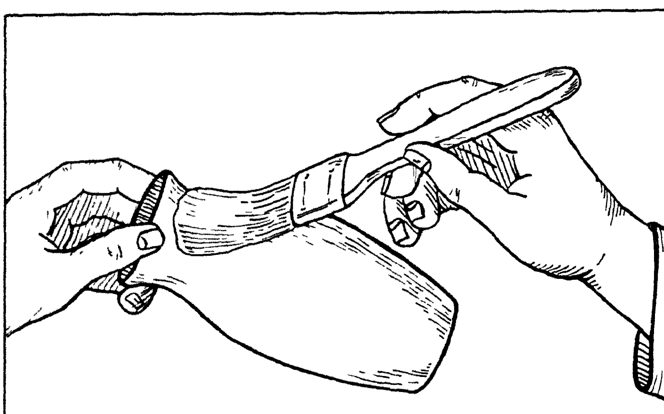

Fig 139 The inside of the piece should be covered with glaze thinned with water, by the pouring process Then the glaze should be flowed on the outside. It should be remembered that heavy brushing takes off as much as it puts on.

Painting with a brush is a slow process, and is convenient only under special conditions. It may be used on the unfired shapes and on the biscuit forms where the glaze batches are very small or where a wide variety of colors is used on a single piece. The problem in brushing on a glaze is to get sufficient glaze on the piece and to cover the entire surface evenly. Glazes are opaque, and after one application the piece will look covered, but there is more to the process than mere covering. The dish must not only be covered, but well covered. It should have a coat

nearly 1/16 in. thick, and that over every inch of the *entire* surface. A spot will make a displeasing effect.

Brushing probably demands a greater degree of care than any other method, and is also the slowest one. However, it is very convenient at times and should not be overlooked in the beginner's experience. In brushing on a glaze, leave the biscuit piece dry and take advantage of any suction the ware may have. Go completely over the piece two or three times, allowing each coat to dry between applications. The main advantage of this method is that the ware can be handled almost immediately and can be trimmed and packed in the kiln at once. This is important where space is limited.

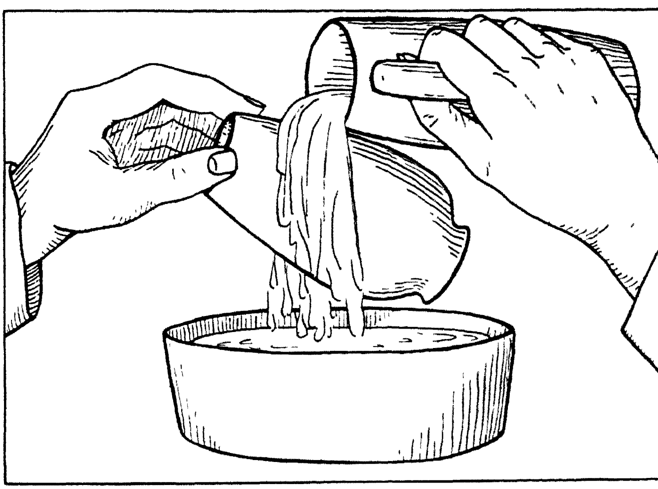

Fig. 140 Before pouring glaze on the outside, soak the piece in water, dry slightly, and then glaze the inside Next, pour the glaze over the outside covering of the piece as evenly as possible. Have the glaze very thick, and shake gently to even the coat. Dry in a warming oven, retouch, and trim the bottom.

The Pouring Process. To either dip or pour glaze on a piece of pottery, first prepare the ware by soaking the biscuit pieces in water, in order to overcome any suction which might develop. Soak all biscuit pieces to be glazed until they are saturated, and then set them out to dry until the surface moisture has disappeared.

With a good batch of glaze and a cup in hand, pour a quantity of glaze into the inside of the piece. Turn the form gently around until

the inside surface is perfectly coated, then empty the dish, shaking it lightly to remove the surplus glaze. Holding the piece upside down over the glaze pan, pour the glaze over the outside; then, after gently shaking the piece, set it up on stilts in a warming cupboard to dry.

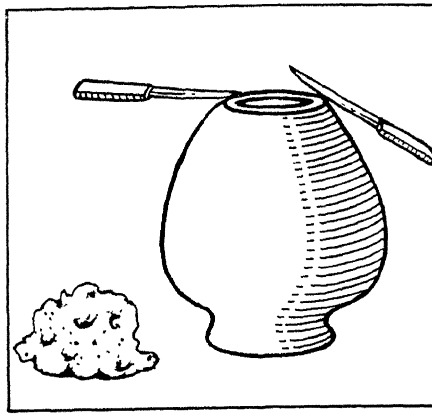

Fig 141. After the piece has been glazed, trim the glaze off the foot, and then sponge the bottom and the foot. Retouch with a thin coat of clear glaze

When the piece is dry, trim the glaze from the foot with a knife, and sponge this edge gently so that the glaze will not form drops and keep the piece from sitting evenly on its base. The glaze may be left in the center of the bottom as a covering, or it may be scraped off and a thin coat of clear glaze may be applied in its place.

With a brush full of the same glaze, retouch the places where the dish was held when the pouring was done. As soon as this retouching is dry, the piece is ready for the kiln and may be placed in readiness for packing.

Spills, blends, and a variety of color combinations may be had by brushing different colors of the same type of glaze on top of the original glaze surface. Soft, delicate contrasts can be obtained by using colors close together in values, while striking contrasts come as easily by using combinations far apart. For example, a light-blue background with a spill of dark or royal blue gives one type of glaze combination, or a light and a dark green together, while dove gray and chocolate brown produce quite another effect.

Packing the Glost Kiln. The packing of a glost kiln is a more difficult task than that of biscuit firing, because it is necessary to guard against the pieces coming in contact with anything in the kiln. A space of ½ or ¾ in. must separate all the pieces from one another, while good stilts must be used for supports for the bottoms. It is especially important that the shelves be placed in the kiln in such a manner as to remain perfectly steady during the entire firing. A slight settling may

cause the pieces to slide together with disastrous results. Use plenty of clay to wedge the shelves in place.

Before starting to pack, have at hand a generous supply of props, shelves, and stilts. Carefully study the kiln and the temperatures of the various locations in it. Pack the hard-firing glazes where the greatest heat comes and the softer ones in the cooler spots. Place all the shelves so as to utilize every available space. Any bare spots on the shelves where soft glazes may drip should be covered with a coating of flint.

Cones. Set about three temperature cones in places where they will be easily visible to the eye from the spy hole, and at a point of average temperature. These cones are stuck in a piece of clay and are leaned at a slight angle in the direction of their melting ratio. For example, 07, 06, and 05; or 06, 05, and 04, are common groups to use. If possible, do not have a large piece of pottery as a background for the cones, for when the temperature reaches about the finishing heat, the color of the cones and the dishes are so nearly the same that it is very difficult to distinguish the cones.

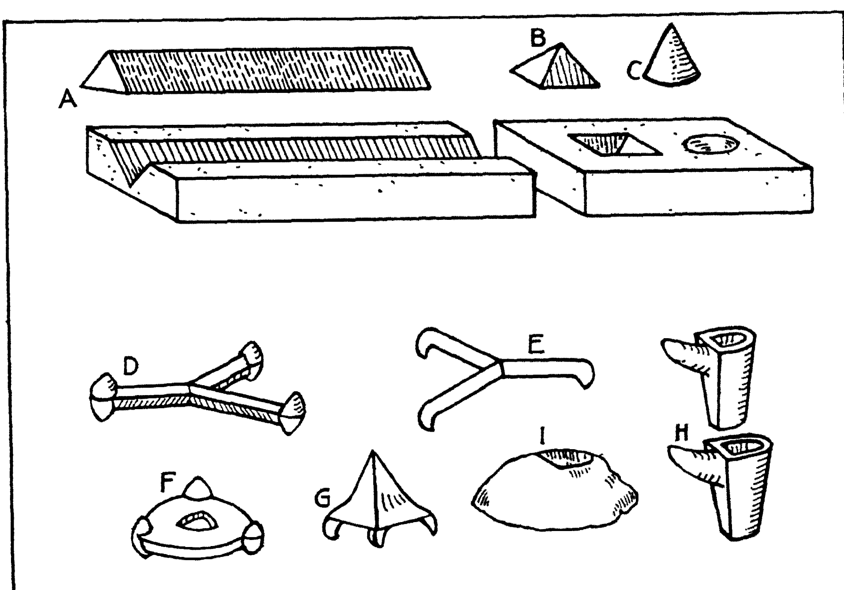

Fig. 142. *A, B,* and *C* are types of stilts which a homecraftsman can make of clay in plaster molds. *D, E, F,* and *G* are commercial types. Two thimbles, used for packing plates, are shown at *H,* and a clay support for the first thimble is shown at *I.*

Shelves. Homemade shelves and props will last longer than the ones purchased from the factory. Use about 1/3 grog and the rest a good grade of fire clay. Mix to a stiff dough and roll out into slabs 1¼ in. thick, and to a dimension suitable for the space to be fitted. It is well to be rather generous with the use of supports, for the life of the shelves is greatly lengthened in that way. Where shelves extend for long distances, place supports in the middle as well as along the two sides.

Stilts. Stilts or supports for the ware may be made or bought. For biscuit firing, long triangular strips pressed from a plaster mold can be used, while for glost firing small pyramids can be made in the same way. Again, some authorities make a composition mixture which crushes easily and does not stick to the glazed surfaces and may be used in both the glost and biscuit firing. However, the commercial stilt is very satisfactory, inexpensive, and will answer all needs nicely. These may be purchased in a wide variety of sizes.

Firing. The firing of a glost kiln is very similar to that of a biscuit kiln. The gradual increase of heat is the prime essential in both cases. The slow start, however, is not so vitally important as in the biscuit firing, as there is not the danger of breakage from moisture that there was at first. In fact, glazes are developed better in a sharp fire than in a slow one, but avoid sudden jumps in temperature in either direction in both firings. As the back of the average portable kiln is always hotter than the front, feed a little more slowly there in order to keep an even temperature.

Carry on the firing until the last cone is down, or until the heat is well beyond the melting point of the glaze. This gives any glaze that is inclined to bubble a chance to smooth down before the cooling commences. Discard glazes which are inclined to bubble through overfiring. This trouble may arise from sulphur in the clay and not be the fault of the glaze at all.

Cooling. Cooling of pottery is just as important as the firing, and should be done very carefully and slowly. Shut all the drafts and let the kiln stand for ten or twelve hours. Then open a few of the drafts and allow it to stand for several hours more until the ware can be handled. Many glazes can be damaged as badly through too rapid cooling as through any process of firing. If carefully done, the percentage of loss should be light in either case.

But, after all is said on the subject of firing, the fact remains that

there is no teacher like experience, and around the burners and spy hole a multitude of items are left unsaid that come to one only through long hours of labor.

Unpacking. Unpacking is always an hour of anticipation and excitement. Often some of the pieces are works of art while others sink back to mediocrity. It is an hour, too, for care, for the razor-sharp edges of broken stilts and glazes cut like knives, and if not guarded against, do serious injury to the hands and arms. Keep a steel chisel at hand for prying off refractory stilts and bits of glaze. Where necessary, grind the bases on an emery wheel to make the pieces stand true.

The Metropolitan Museum of Art
French twentieth-century stoneware vase.

CHAPTER XIX

Problems and Defects

IT IS manifestly impossible to anticipate more than a few of the most common problems and difficulties which may arise in the experience of the average beginner and craftsman of pottery. However, some suggestions here may prove helpful.

Clay. Some clays which appear otherwise to be very satisfactory are so fusible that even at a low temperature they are inclined to melt. Such a condition is usually due to the presence of a large percentage of fluxing minerals in the clay, such as iron and other oxides. To remedy this, it is necessary to add a more refractory clay. As much as 50 per cent may be added without upsetting the fitting of a desirable glaze. If a large ball mill is at hand to grind and blend the mass, grog may be added with good effect. The grog, too, will be found helpful in reducing the tendency of the clay to shrink, which is a problem in some kinds of work. A satisfactory ball mill may be built out of an iron barrel. (See illustration in Chapter XX on Equipment.)

Some clays are so plastic that it is almost impossible to throw them upon the wheel. Improve the mixture by the addition of another less plastic clay or some grog. If the clay is too short and cracks when thrown, except in thick pieces, add more plastic clay.

Casting Clay. The slip may be too slow in forming in the mold, or it may be too thin for good casting. Slip, to work well, should be thick and creamy, so that it will pour smoothly. It should also set for a time, as casting clay improves with age. If the clay is too plastic or very adhesive so that it fills the pores of the mold and shuts off the casting process, add grog or a refractory clay. If the clay is too short and cracks in the mold, add a more plastic clay or reduce the amount of grog.

Plaster Molds. The molds of plaster are soft and crumble easily. When they are old, the plaster finally loses its strength due to the ab-

sorption of moisture from the air. Molds may have been overheated in drying, too little plaster may have been used in the casting, or the mixture may have been stirred too long before the plaster was poured around the form. Always use fresh plaster, and a sufficient amount to make a good mold, and never continue to stir after the setting process has once begun. Plaster will crumble in drying under a high temperature.

The castings may stick to various places in the mold and not set well. In this case clean the mold with gasoline to remove any touches of sizing which may have been left. It may be necessary, however, to use new molds for several castings before the suction is even and good.

On occasion, castings give way before the clay is set, and fall in a mass inside of the mold. This difficulty may be remedied by turning the mold upside down after the casting is done. If the bottom falls in, wait a while before turning the mold over. Sometimes this difficulty can be overcome by increasing the size of the spare at the top of the mold. Molds with wide diameters and narrow necks should have a generous spare added to the top in order to give the clay a gripping surface until it has had time to stiffen.

Glazing and Glazes. A piece may come out of the kiln with a thin, impoverished appearance. All pieces when glazed must have a sufficient coating to insure a deep rich covering to the surface of the article. Use a thicker glaze and be very careful to cover the entire surface evenly.

A glaze may peel from clay which before has been satisfactory. Examine the surface of the biscuit piece before it is glazed, and brush off any dust from the sanding which may have been done before the biscuit firing. Any dust will cause the glaze to crack as it dries, and these fine cracks will in turn cause the glaze to peel and run from the pottery when fired. If there is no dust, a little additional gum tragacanth may stop the peeling.

If the glaze is very liquid and runs badly from the pottery, try stiffening it with more flint and a little kaolin. If it blisters, forming craters which remain after cooling, there may be too much sulphur in the clay. Practically all clays contain some sulphur, and when in excess it will create the trouble described. A small quantity of barium carbonate added to the clay will usually improve the situation. If the glaze is a yellow or orange, it may be necessary to reduce the amount of antimony

oxide used since that oxide is inclined to form a blister which will not go down in cooling.

If the gloss glazes turn to matts and the matts to gloss, check the feldspar. There are nine or ten kinds of feldspar, and only one is good for the low-temperature glaze making. Be sure and get the orthoclase feldspar or you may have many freakish results. Have the chemicals all ground through the same mesh, say two hundred, as even such a minor item may cause trouble.

Matt glazes often turn to a gloss. These glazes are more exacting, and cannot be overfired as much as glosses. Watch where they are placed in the kiln. If they continue to bother, increase the quantity of kaolin.

If glaze crazes when taken from the kiln, try slower cooling, or increase the quantity of flint. A new glaze formula may be necessary, and the clay mixture, if possible, may have to be changed.

A piece may sweat when filled with water. This is a type of slow leak and means that the glaze did not entirely cover the ware. Try firing the biscuit or the glost kiln harder. If this does not help, treat the pieces to an application of smoking-hot paraffin. The paraffin will not hurt the ware in any manner and is usually a certain cure for leaky pottery. If the weather is cold, heat the pottery quite warm and the paraffin smoking hot.

Cracks. To patch cracks in pottery make a paste of half grog and half regular clay and run through a 50-mesh screen. Then moisten it with silica of soda. Work the mixture thoroughly into the crack and then let it dry before glazing.

If you do not wish to bother with the silica of soda, the earthenware formula, given in Chapter XXI, General Information, will make a paste, when used with water, that works nicely for patching cracks.

If, in firing, the gloss glazes turn into a dull, devitrified surface, there may be two causes for the trouble. The feldspar may not be from the potash or orthoclase group, or the white lead may have impurities in it. White lead may be purchased most economically from the paint companies in 50- or 100-lb. lots. However, test each new batch before being put into general use. Calcium carbonate or other impurities of a foreign nature in the lead can completely upset a glaze.

CHAPTER XX

Equipping a Pottery Shop

THE character and amount of the equipment for a pottery shop depends on the owner's objective. What is to be made? Novelties, inexpensive pottery, highly expensive artware, porcelain, or what? Is it the potter's aim to follow an avocation or a hobby, or to develop a productive business? What is the capital available? And how much is the initial investment?

The Demands of the Work. The demands on the pottery producer are more or less exacting, and yet there are many pleasant satisfactions to offset the difficulties and disappointments of the craft.

In an age when nearly every venture demands an initial capital of considerable size, the pottery factory offers an encouraging feature, in that the individual may start in a small way and increase his investment with his business. It is true that there are certain costs to be met, such as the purchase of a kiln. As a beginning, the kiln need not be of the large, costly brick type. There are a number of very satisfactory portable kilns which do efficient work and which are within the range of the average individual. These kilns are never amiss, for, when their capacity grows too small for general use, they are always in demand for special orders and experiments.

The building may be of the simplest construction. An old shed or barn does nicely when nothing else is at hand, and a deserted garage may be turned into a place of delight to the potter's heart.

Most of the equipment can be made in the shop at little cost. A lathe good enough for all the demands of the shop can be made for about \$12, while the potter's wheel desired can be made for about the same cost. Screens or sieves can be bought for \$2.50 each, or can be made for 75 cents. Whatever can be made at home should be made by the individual, and good judgment should be used in buying parts. For ex-

ample, a used motor will do nicely for the lathe, and can be purchased for nearly half the price of a new one. Vinegar barrels make excellent containers for slip, and can be purchased very cheaply. Old enamel pans with leaks soldered, or filled with plastic wood and covered with a good lacquer, make containers in which clay can be stored for a long time.

In the following paragraphs, a list of most widely used items necessary in pottery work, is given. The illustrations are suggestive and will aid anyone in better judging his own needs.

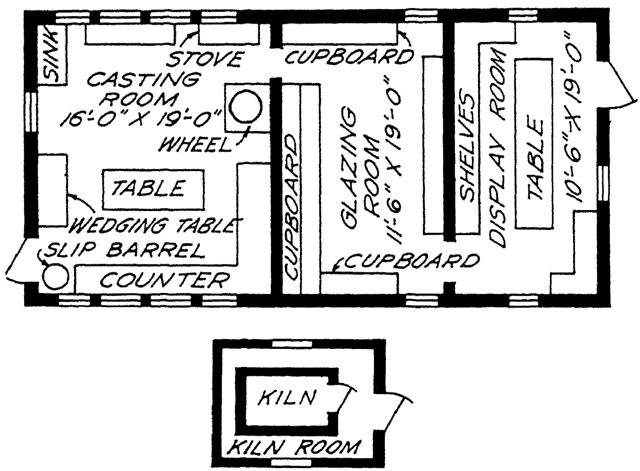

Fig. 145 An approximate floor plan of a small successful studio started in the author's community some years ago.

Equipment. After deciding upon a building, a kiln must next be chosen. The following list of necessary equipment consequently begins with a kiln:

A small brick kiln, or large portable kiln
Small trial kiln
One or two potter's wheels
Homemade or cheap lathe
Lathe tools and potter's tools
Damp cupboard
Vinegar barrels for slurry and slip
Screens for screening clay (40 to 50 mesh)
Buckets and pans for clay and plaster
Mortar and pestile
Small ball mill, preferably power driven
Glaze pans
Glaze screens (100 mesh or more)

Brushes for glaze
Several tables
Wedging boards
Chemical cupboard
Set of gram scales and weights
Spoons for weighing chemicals
Complete line of chemicals, as suggested in Chapter XVIII on Glazing
Calipers for measuring various sizes
Tin snips for cutting templates
Hammer, saw, nails
Clay bins
Numerous shelves
Showcases and display tables
Plenty of shelves and props for the kilns, or saggers for the brick kiln
Supply of good fire clay for bedding kiln and repairing leaks

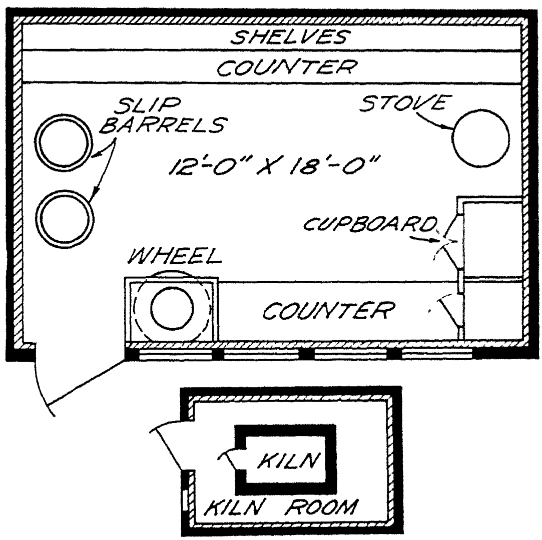

Fig. 146. An approximate floor plan of a small shop which was cheaply built and without finish on the interior. It served its purpose well, and is within the range of any ambitious individual.

All of these things and many more not listed will be found in the average shop. Outside the price of the kilns, the rest of the equipment should not cost so much as to hinder one from taking up the work. A kiln will cost from $250 up, and is the most important item. China kilns, though much cheaper, are not to be recommended in the long run, as they are not built to withstand the long-continued high temperatures to which all pottery kilns must be subjected.

This long list of equipment should not, however, discourage the would-be potter who wishes to experiment with pottery as a primitive

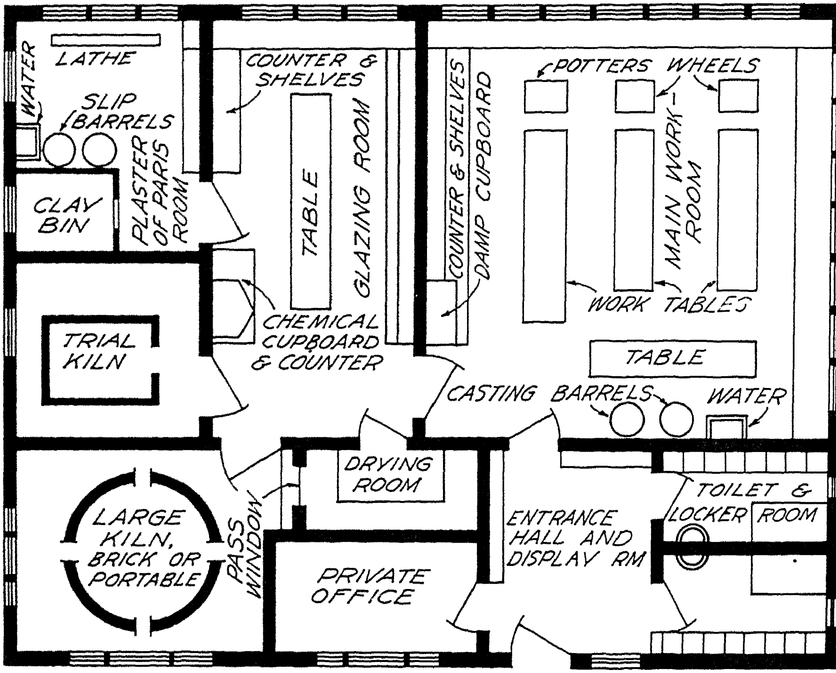

Fig. 147. A suggested plan for a large shop. This plan can be scaled with a 3/32-in. scale, which will give an approximate outside dimension of 37 by 48 ft. However, for school work, double that size would be better.

art, for there are no limitations of mere equipment to deter him. With care he can take his clay from the original bed, untouched by any process of screening, and model his pieces as his fancy dictates. Then, like primitive man of old, he can bury his pieces, when dry, in the ashes of a previous fire and fire them to a rocklike state without kiln or equipment of any kind.

A Craftsman's Shop. Some years ago, the author was in touch with a little shop, behind whose doors many pieces of interesting pottery were made. It was the simplest possible kind of shop, built by the owner for the love of the work, carried on as an avocation in spare hours. Although the objective was not money-making, the work prospered to such an extent that the returns were very satisfactory in every way.

The floor plan of this building is shown in Figure 145, and that of another good shop will be found in Figure 146. Both plans illustrate

how compact a shop can be built and yet prove a success. The first structure has an actual floor space, outside of the kiln room, of 12 by 18 ft.; and the second, which is a bit larger, has a total floor space of 20 by 40 ft. Both are small and yet proved successful. The first was originally an unused shed, and the second was an old garage.

The following is equipment for the first shop with the approximate cost:

The shop itself	$ 40.00
Kiln (including freight)	200.00
Smokestack for kiln	10.00
Potter's wheel	6.00
Two barrels for slurry and slip	3.00
One wedging table	1.50
Two old candy buckets for water	.25
Mortar and pestle	1.00
Gram scales and weights	20.00
Wood stove	3.00
Drying cupboard (made from boxes)	1.50
Screen for clay	.75
Screen for glaze	.75
Turning tools (from scrap iron)	No cost
Sponge	.05
Plaster molds	.50
Barrel for fuel oil	1.50
Valve for barrel	1.00
Damp box (made from old packing box)	.15
Storage, drying, and display shelves	.50
Chemical cupboard	.75
Chemicals as needed	10.00
Temperature cones, per order	2.40
Fuel oil, per order of 50 gal.	6.00
Extra shelves for kiln, homemade	.50
Stilts, purchased or homemade	1.00
(Pans and containers were made from leaky enamel pans soldered up at little cost except labor)	
Total	$312.10

From this shop, several hundred dollars worth of pottery was sold each year. The production was divided about equally between casting and throwing. Special orders were given particular attention so that unusual pieces could be made. It was an interesting place, a little shop belonging to an individual who loved the work and made many friends. Unfortunately, the owner's regular work became too heavy, so that he had to give up his little studio.

The second shop is still in operation, and, in fact, is an outgrowth of the first, and the equipment is very similar. Art pottery, novelties, and special orders are the types of work; while casting, throwing, and pressing are the methods of production.

Pottery Wheels. If money is no item, very fine, motor-driven pottery wheels can be purchased from reliable dealers, for somewhat over $200. Such expensive machines, however, are not necessary in a craftsman's shop. Kick wheels can be built at a very moderate cost and are satisfactory for ordinary needs.

There are two types of these kick wheels, of which one has a pedal and the other a flywheel. Each produces good work and can be used for both throwing and turning. The pedal type is lighter and more easily moved about, and is more satisfactory for throwing tall pieces. The pedal type, however, is more expensive, the average cost being

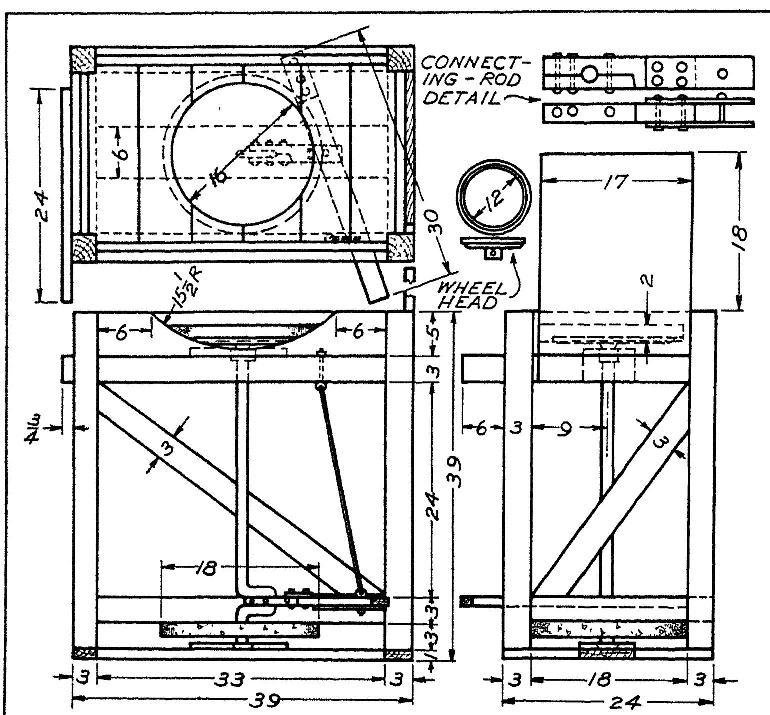

Fig. 148. Detailed drawing of potter's wheel.

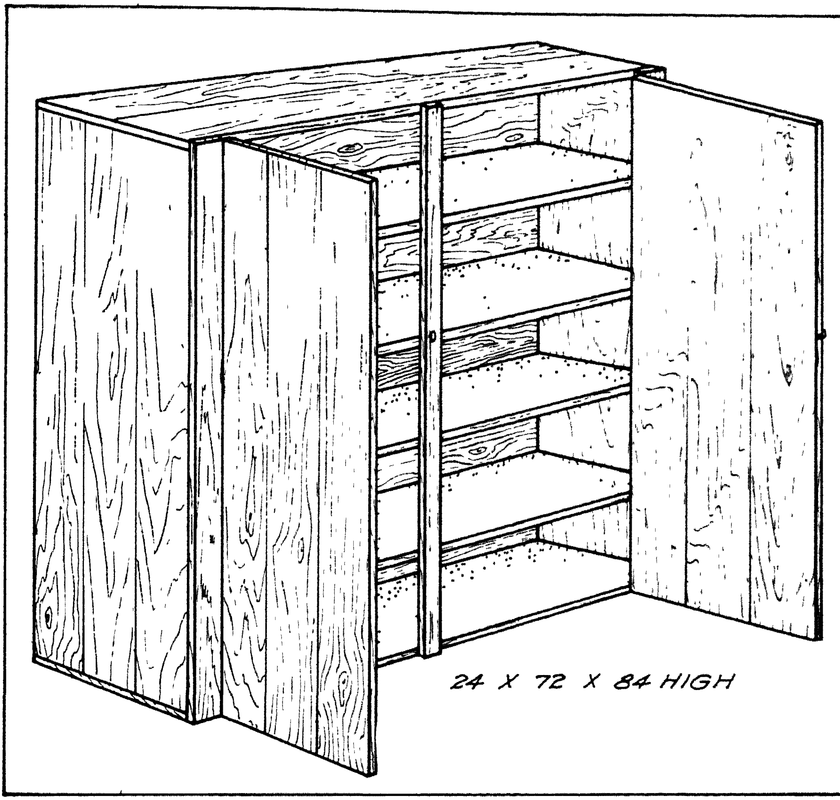

Fig 149. The shelves of this damp cupboard should have a coating or layer of plaster so as to retain the moisture

about $15 as compared with $6 for the flywheel type. The worker, too, cannot sit as conveniently at the pedal wheel as he can at the flywheel model. Both wheels are shown in Figures 148, 151, and 152. Where practical, it is well to have one of each, the heavy one for turning and trimming pieces, and the pedal type for throwing.

The parts for both wheels can be obtained from any garage. The lower bearing should be some kind of a ball bearing of the thrust type, and the upper one should be either a roll or ball bearing which will steady the shaft and run easily. The spindle in the flywheel model can be made from the drive shaft of an automobile, but in the pedal design some lighter shaft should be used. In the flywheel model, the wheel

itself is about $2\frac{1}{2}$ ft. in diameter and 6 in. thick, and is made of concrete. The form should be made level around the shaft, and the concrete poured into it. This wheel should just clear the bearing at the bottom by 5 or 6 in., leaving enough room to oil or grease the bearing occasionally. If the surface of the concrete is left rough, the foot will not slip when the kicking is done.

The seat of the flywheel type is on a slant so that the operator can be closer to his work. This wheel is operated by sitting with the left foot braced on a footrest at the back of the wheel, and the mechanism

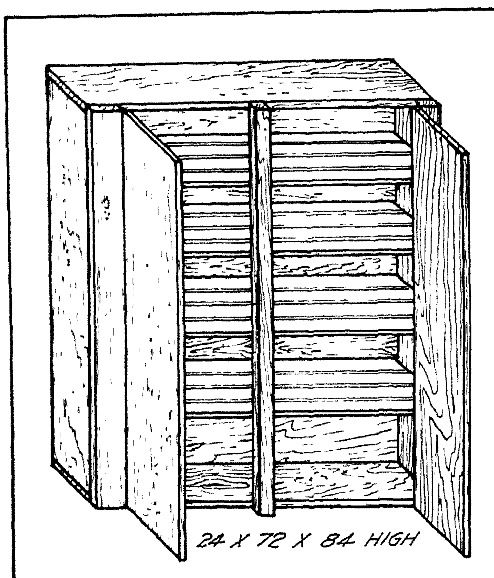

Fig. 150. This drying cupboard should be lined with metal and have slatted shelves so that heat from an electric stove or reflector can circulate evenly.

is propelled by kicking on the flywheel with the sole of the right foot. After the wheel is once started, it runs easily and will need only an occasional kick. Between strokes, the right foot can be rested on a footboard which is under the seat at a level with the flywheel.

The wheel head on both wheels can be made from an old brake drum or a similar metal piece. It may be filled with a block of plaster turned true to the wheel.

The flywheel on the pedal model is of less importance, and is placed there simply to give momentum to the wheel. It should be heavy enough to be practical for the purpose and no heavier.

The pedal type is operated by standing upon the left foot and kicking with the right, leaning more or less against the frame of the wheel. In both models the wheel is turned so that the head revolves from right to left.

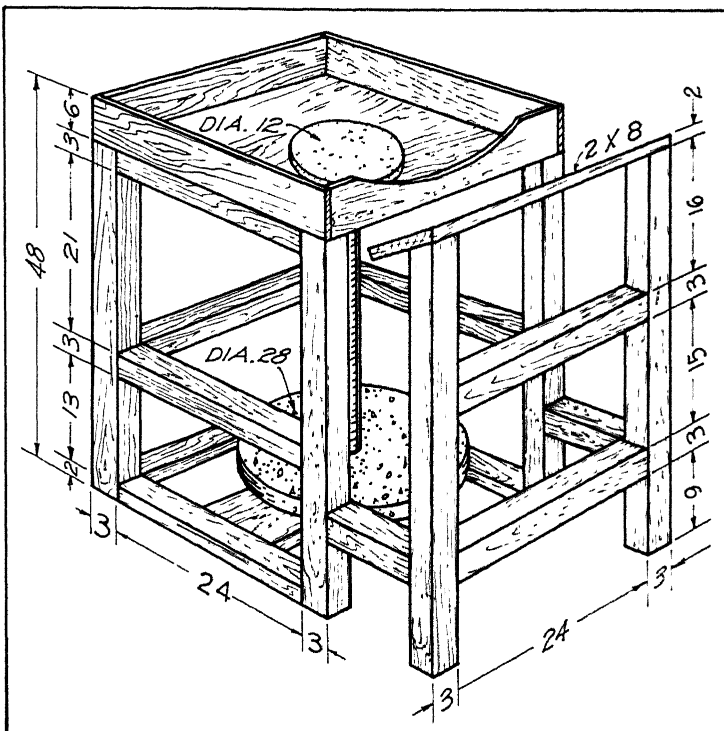

Fig. 151. This simple kick wheel can be cheaply made, and is excellent for turning and trimming pieces. It also can be adapted to platemaking. The frame can be made from 3 by 3-in. stock. The upper bearing is a roller bearing and the lower a thrust bearing from a discarded automobile.

Turning Tools. A set of tools is necessary in the process of turning, and should be made by the individual interested. Some potters will want a wider variety of tools than others. Figure 154 gives an idea of the types most commonly used. They are generally named by the form

of the ground edge, and are round-, skew-, and square-edged tools. They can be made from malleable strap steel, about 3/16 in. thick and 1 in. wide. Usually they can be bent cold and the edges ground on any ordinary grinding device. Special shapes can be made as the worker wishes. The loop-type of tool, as shown, is one of the specially made tools. It can easily be made from an old band-saw blade.

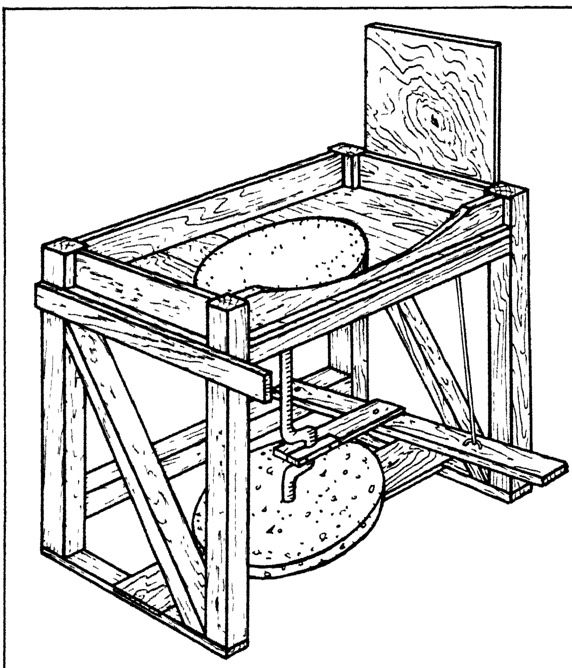

Fig. 152 This crank-propelled wheel can be built for a small sum, and can be made to be kicked with either the right or the left foot See Fig. 148 for dimensions

The pricker, rib, calipers, and cutting wire, which are used only in throwing, are also easily made. The pricker can be ground from a light piece of wire, the rib may be cut from a sheet of copper; the calipers usually are cut from some strips of wood, and the cutting wire is made from any strong fine wire which does not stretch easily.

The Wedging Board and Damp Box. This part of the equipment is not hard to build and can be made any size to suit the needs of the

shop. The table should be solid and firm, and the box should be tight. Both should have a thick slab of hard plaster of Paris as the main working surface. Plaster is very helpful on the top of the wedging table to dry out and stiffen the clay, and in the bottom of the damp box to keep the clay moist. In both places the layer of plaster of Paris should be several inches thick and quite hard in order to insure against breakage.

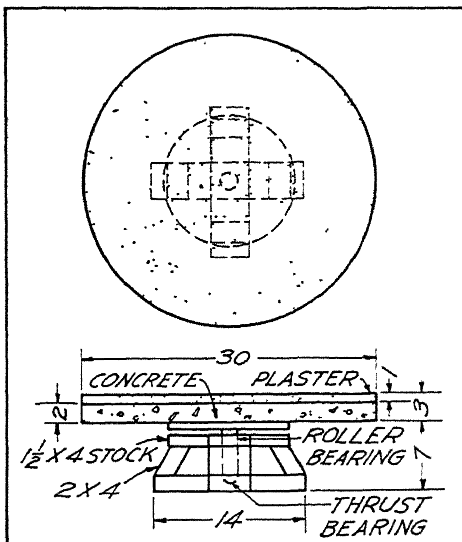

Fig. 153. A modern adaptation of the Indian's pottery wheel. The top is made of concrete and plaster, and the bearings and shaft are old car parts. It is an interesting wheel propelled by grasping the edge with the hand and giving a vigorous pull.

Damp cupboards are built on the same principle, and should have serviceable plaster-covered shelves to keep unfinished work moist.

Kilns. The kiln probably offers the biggest problem to the worker entering the ceramic field. For glazing, a kiln is an absolute necessity. Before a kiln is bought, the kind and amount of work to be fired and the fuel to be used must be decided upon. Pottery may be fired with every type of fuel from natural gas to wood, depending on the locality, the ware, the kiln used, and similar problems. Probably, however, gas

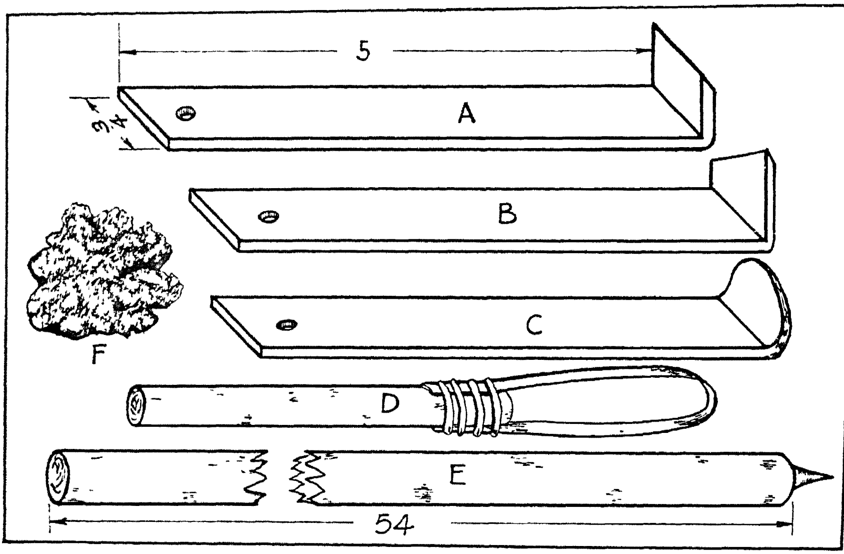

Fig 154. Turning tools. *A* and *B*, square and skew-pointed tools used in smoothing surfaces; *C* and *D*, roundnosed and loop tools used in making rough cuts; *E*, tool holder or turning stick made from a broom handle with a sharp nail for a spur. *F*, sponge used to wipe the piece when the turning has been completed. The loop tool at *D* is made by wiring a piece of handsaw blade to a round stick.

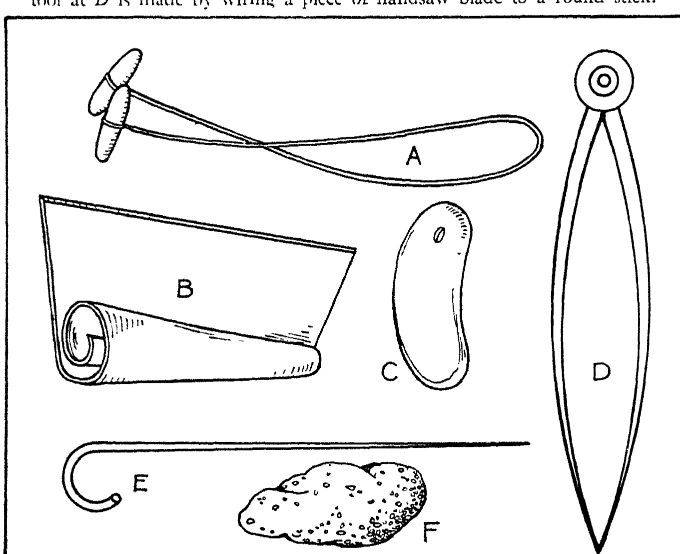

Fig 155 Tools used in throwing. *A*, cutting-off wire; *B*, outside rib, *C*, inside rib; *D*, calipers; *E*, piercing tool; *F*, sponge.

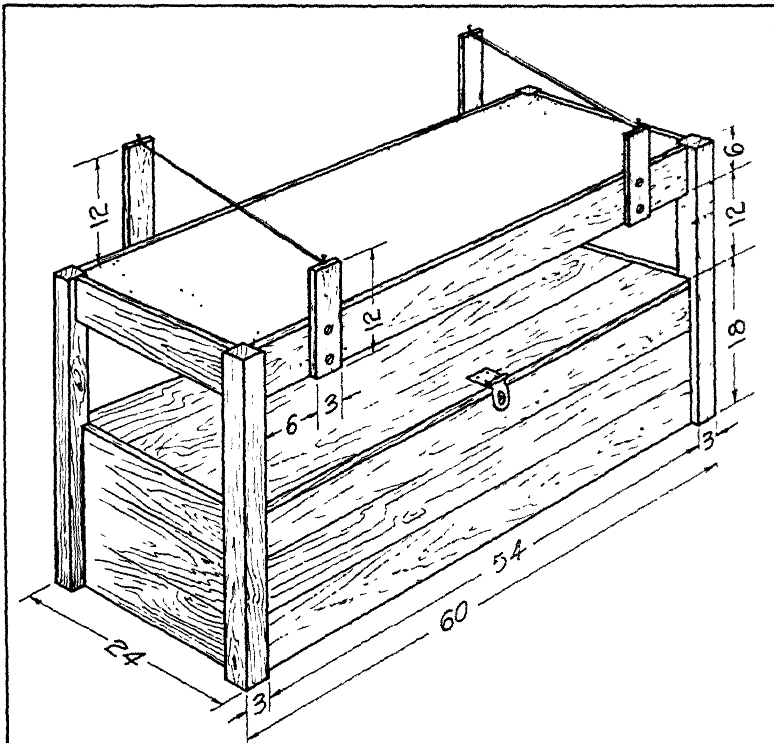

Fig. 156. This large-sized wedging table is made of casting plaster supported by a layer of concrete and a plank. The box has a plaster bottom and is used as a storage bin.

or oil will constitute the most economical and convenient mediums of heat. Natural gas is very satisfactory, but not always obtainable; oil in some form usually may be considered as the most universal fuel. Kilns can be built which will burn any kind of oil, though most studio kilns use kerosene. This, however, is not the most economical fuel. Kilns which have a motor-driven feed and use a heavier and cheaper kind of fuel are more desirable. The installation of one of the heavier fuel burners is more costly in the beginning, but pays back the investment in a short time in the reduced fuel outlays. The average gravity-feed burner is not very economical, and is also somewhat temperamental.

After deciding on the kind of fuel to be used, an estimate must be made of the size of kiln needed. What is the average output? Will this

output grow, remain constant, or decrease? In this connection arises the question of the permanence of the location. A portable model would almost be a necessity if there is a likelihood the kiln is to be moved. If the plant is permanently located, a built-in model would be

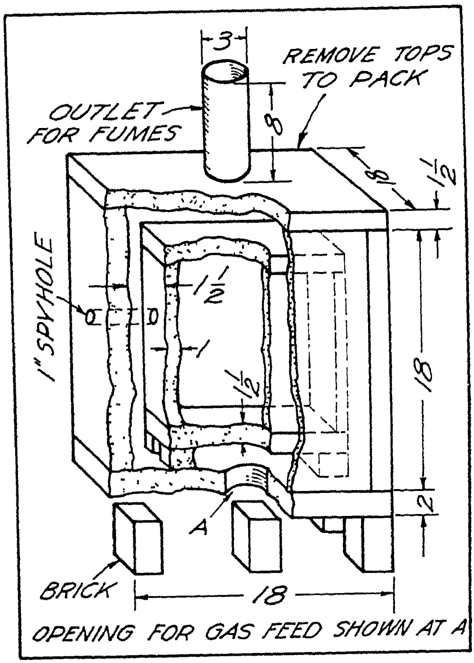

Fig. 157. This small, trial gas furnace can be built by anyone. It will give fair results and is worth trying. Use a good grade of fire clay and grog in the proportions of two of clay to one of grog. Roll out the slabs with a rolling pin, and when stiff, fasten them together.

just as good. Where work is done on a small basis, a muffle kiln is more convenient than a large kiln using saggers, so the muffle type should be considered.

If the craftsman desires, he can order the muffle part of the kiln and build the outside walls of firebrick himself. This can be done quite successfully if the worker is careful to band his brick wall against the expansion caused by the intense heat. On the other hand, he may prefer to buy a portable kiln complete and ready for use.

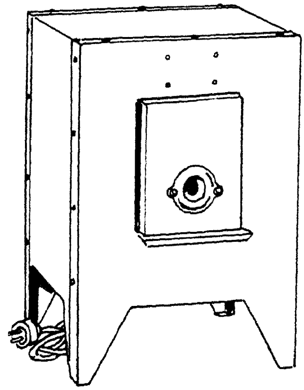

Fig. 158 An electric kiln A small test kiln is a great help in any shop, and an electric model is very satisfactory

A number of excellent portable kilns have been designed by reliable manufacturers, leaving plenty room for individual choice. In these kilns the general principle of construction is much the same. The ware is protected from the intense heat by a number of practical means; hollow fire-clay tubes are used mostly, although one firm constructs its muffle by interlocking fire-clay slabs. The buyer should consider the special points of construction of each kiln, and make which best appeals to him.

Experimental Kilns. For the individual who wishes to fire and glaze only one or two pieces at a time, purely as an experiment, a

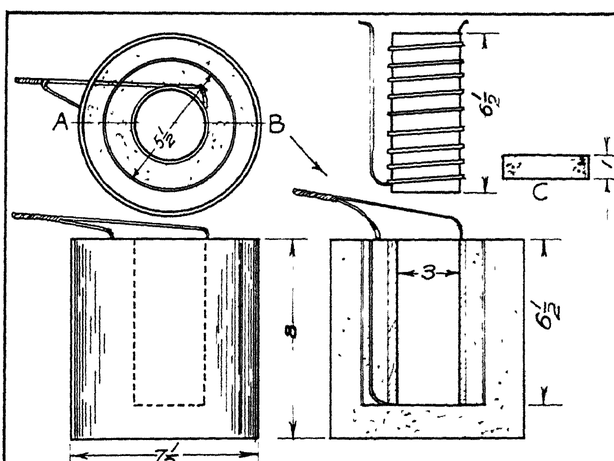

Fig. 159. This small electric furnace can be used for testing glazes. The outer casing is designed for a $7\frac{1}{2}$-in. shortening can. The middle circle is a coffee can $5\frac{1}{2}$ in. in diameter, and the inner circle is made from a cardboard box 3 in. in diameter. The packing consists of two proportions of fire clay and one of grog. A sheet of asbestos is placed next to the coffee can on the inside so that the element may be drawn out. Clay should be packed around the element before it is placed in the can so that the packing will not move it out of place. The cardboard will burn out easily. At *C* is shown a fire-clay cover.

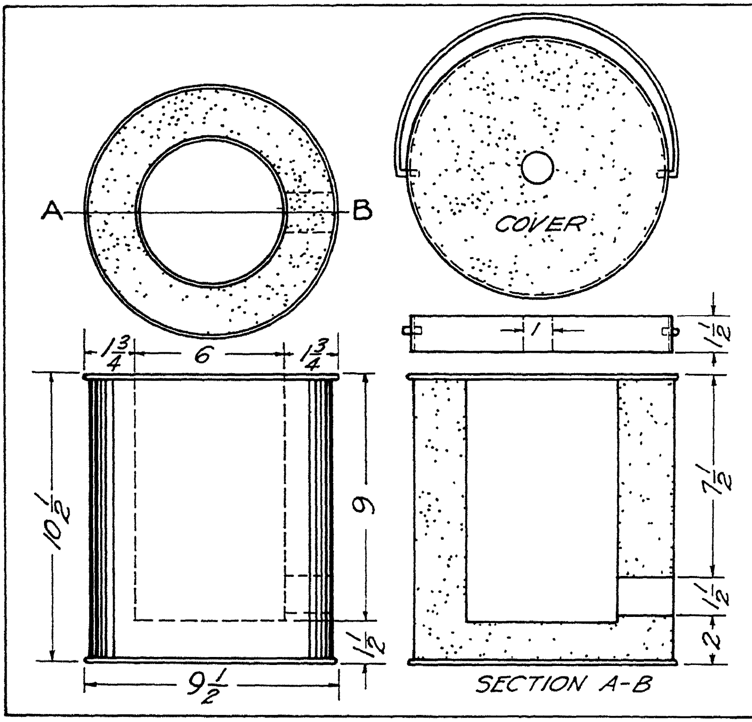

Fig. 160. This small gas furnace can be built at a very reasonable cost. It will hold a No. 7 crucible, and when fired with a good bunsen burner will fire glazes up to cone 05. The outer container is a 2½-gal paint can The inside is a gallon fruit container. The packing, grog, and fire clay are of equal parts. The cover is a 22-gauge iron, banded and filled with the same packing. The handle is a No. 8-gauge wire.

kiln may be built at a very low cost. The principle, however, still remains the same. Glazes cannot be fired in an open flame. It is, therefore, necessary to construct some kind of a fire chamber surrounding an oven or a muffle in which the glazed piece can be fired. A large, old iron pail, with a hole cut in the bottom, and the walls lined with fire clay and grog, will be a good start toward an improvised kiln. Then a plaster mold should be made in which the muffle can be pressed. This muffle should be smaller than the clay-lined pail so that the fire chamber may surround it. For the top of the bucket a heavy fire-clay cover should be made with a hole in the middle as a vent for gases. The muffle should rest upon small pieces of fire clay on the bottom of the chamber.

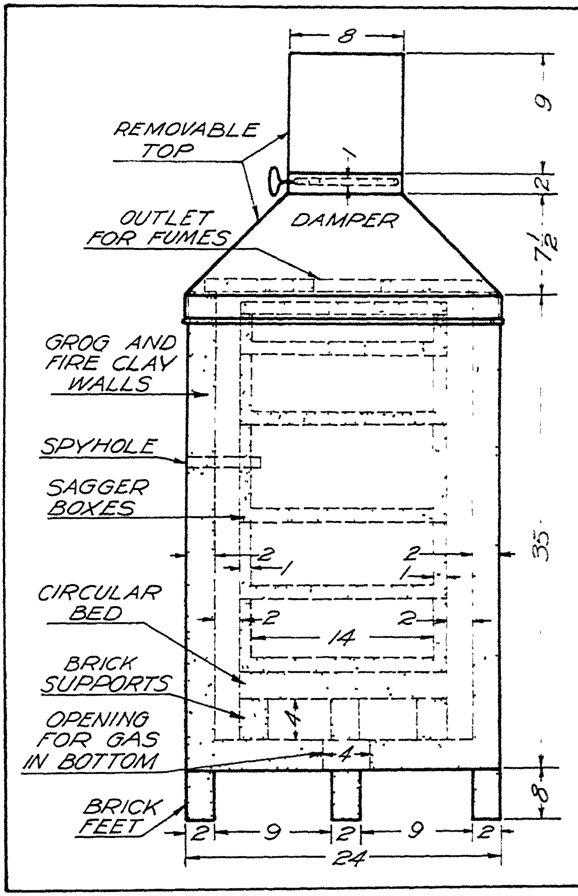

Fig. 161. This is an iron-barrel kiln, and is shown merely to suggest possible methods for making an experimental kiln It is packed from the top by removing the sheet-iron cover. The ware is packed in saggers. The fuel should be oil or gas, fed from the bottom.

The fuel used should be artificial or natural gas fed by a Bunsen burner through the bottom opening. A gasoline torch might be used, but it is difficult to operate under such conditions. The whole process is purely experimental, and though recommended by some, is described solely for what it is worth. If the sides of this little kiln are lined with electric resistance wire, so that electricity can be used, the muffle may be done

away with. The sketch of a kiln in Chapter XIV, Biscuit Firing, will convey more clearly the idea.

Shelves for the Kiln. Every successful packer of a kiln is always on the lookout for plenty of shelves, which may be purchased from any of the firms who manufacture kilns. It is practical to make one's own shelves. These are much cheaper than the factory-made shelves, and also as a rule more durable.

To make the shelves, buy a good grade of fire clay, and pick up some pieces of old firebrick or former broken shelves. Pound up the brick into particles the size of peas. The resulting mass is called grog. Use about one third grog and two thirds fire clay, and make a thick, heavy dough. With a cloth and rolling pin, roll out the slabs or shelves the same size and thickness as those which came with the kiln. Allow only a small amount for shrinkage. Place the clay on the cloth and roll it vigorously with the pin on both sides. Fill up all the holes, trim it square with a knife, and place it aside to dry. When dry, fire it in the biscuit kiln in the same manner as any piece of pottery. As many shelves as necessary can be made this way.

Temperature Cones. Although at present the electric method of measuring heat is the most accurate, an electric instrument for the purpose is too expensive for the average craftsman. The temperature cone

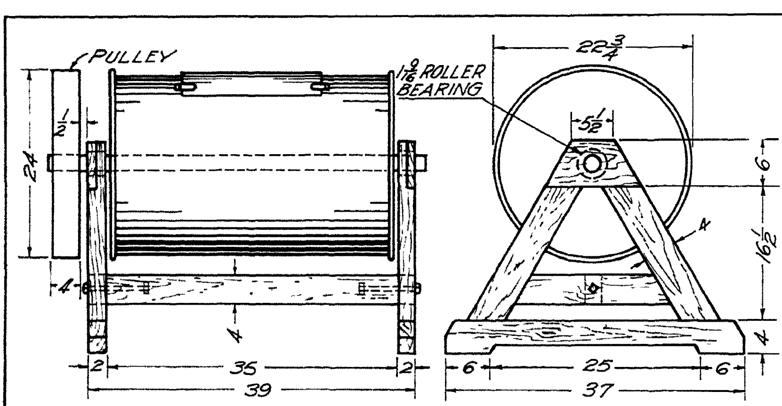

Fig. 162. This improvised ball mill, made from an old iron barrel, can be used for blending clay for casting. The bearings are from an old car or truck. The pulley can be built up of laminated wood, and should run about 80 r.p.m. Smooth, river rock can be used for the pebbles.

will serve his needs very satisfactorily. They come in boxes of 50 and are graded to practically every desired temperature.

Stilts. Stilts are of prime importance in pottery work to permit the heat to penetrate evenly into each piece of pottery. When glazing is finished, they are also necessary to keep the ware from sticking to the shelves of the kiln.

Stilts can be purchased in many and various sizes at a reasonable rate, or they can be made by the individual. The cost is so reasonable

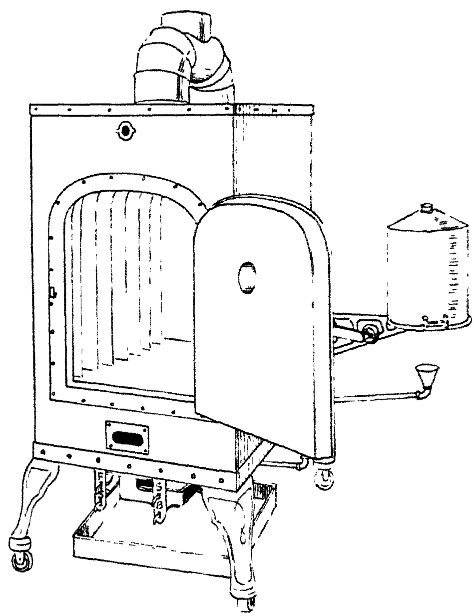

Fig. 163. This tube-type pottery kiln has been a standard for many years. It uses either kerosene or gas.

that it hardly pays to make one's own. However, homemade stilts are good, and are liked better by some packers. One easy method of making stilts is to cut the pattern desired in a block of plaster and then press out as many stilts as are wanted. The clay used should be of such a nature as to stand well the temperatures at which the kilns are fired.

Other packers make a biscuit-shaped stilt, composed of refractory materials which crumble easily when touched with a tool. If the piece

to be glazed has had its base scraped and sponged clean, and then only lightly touched with clear glaze, it will not stick badly to this form of stilt, but will brush off leaving a clean base.

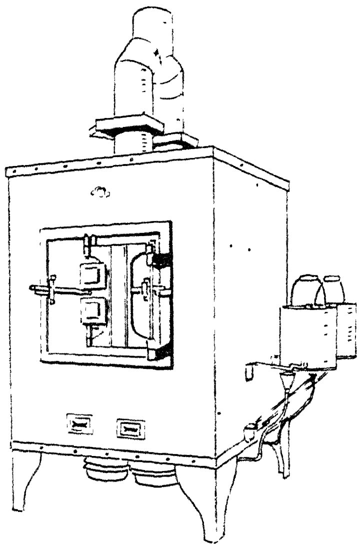

Fig. 164 The walls of this interlocking tile-built kiln are made of interlocking tile instead of tubes

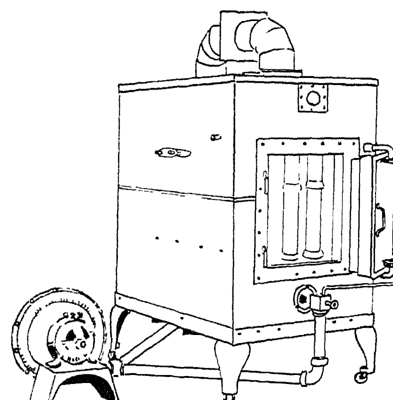

Fig 165 A crude-oil-burning kiln.

CHAPTER XXI

General Information

ANTIMONY (Sb). This element is found as a sulphide, Sb_2S_3, which goes under the name of Stibnite.

Antimony Oxide (SbO). The oxide of antimony is sometimes used in the preparation of glazes and colors, but has an unfortunate trait of causing blisters which do not disappear as the glaze cools. It must be used, therefore, with a degree of caution. The most satisfactory use for it is in the preparation of yellow compound where it is calcined with red lead and tin.

Borax ($Na_2O.2B_2O_3.10H_2O$). Borax is the most important compound of boron. It is found in a natural state in arid regions, such as Death Valley in California, and in Thibet. It is used in the manufacture of soap, as a powerful flux in glass, and in the preparation of fritted glazes.

Calcined Kaolin ($Al_2O_3.2SiO_2$). In the preparation of a glaze, if the formula demands a large quantity of kaolin, a percentage of it is sometimes calcined in order to keep the glaze body from becoming too plastic. The calcining drives off the naturally combined water, and changes the molecular weight from 258 to 222.

Calcium Carbonate (Whiting) ($CaCo_3$). Calcium and its compounds are found in abundance in various regions. Its most abundant form is the carbonate. Calcium carbonate, or whiting, is used in the preparation of glazes to give them durability. It also governs somewhat the fusibility of the glaze and the raising or lowering of the melting according to the amount used.

China Clay or Kaolin ($Al_2O_3.2SiO_2.2H_2O$). Kaolin is a pure, creamy white clay formed through the decomposition of feldspathic rock. It is used in small quantities in the preparation of glazes, and in the pastes which go to make up porcelain and other lines of white ware.

Chrome Oxide (Cr_2O_3). Chromic oxide is a green powder used in the preparation of glazes to give greens, browns, and blacks.

Chrome-Yellow Ocher. This is a compound of chromium, which can be obtained from any dealer in coloring materials. It is an inexpensive source for yellow in the preparation of a glaze. It is not particularly strong and can be used in rather large quantities in the same manner as oxide of iron.

Cobalt Oxide (CoO). Cobalt and nickel are nearly always found in combination in ores which also contain other metals such as iron, silver, and copper. The oxide of cobalt is a very strong colorant, making all shades of blue.

Copper Oxide (CuO). Metallic copper was probably one of the first metals to come into use. This may be explained by the fact that it occurs in many places in its natural state, and is easily hammered into any desired shape.

In the pottery industry the oxide of copper is widely used to produce various shades of green. Its remarkable changes of color under a reducing flame give an added charm to pottery when the worker wishes to produce a variety of colors. Browns, blues, blacks, and reds are some of the possible colors produced by the reducing method.

Feldspar ($6SiO_2,Al_2O_3,K_2O$). Feldspar is found in nearly all crystalline rocks such as granite and rocks of a similar nature. The gradual wearing away of these rocks has resulted in the formation of the different constituents of the soil. Feldspar is one of the important materials which go into the compounding of a good glaze. Before buying feldspar careful tests should be made of samples to be sure that it will work exactly right in the glaze. Some feldspar will do fairly well in a gloss formula and not react right in a matt, and still others will cause trouble in both, so it is well to test it thoroughly before laying in a large supply. In buying, ask for potash feldspar, called orthoclase by mineralogists.

Flint (SiO_2). Just as carbon has a most active part to play in maintaining life in living creatures, so silica has a definite place of the same nature in the elements and compounds which make up our soil and rocks. At an ordinary temperature flint is inactive, but at a higher temperature it combines with other elements. When calcined and ground to a fine powder, it is used as an important element in glaze preparation. By itself in the average temperature at which faïence

is fired, silica remains a white powder, but combined with white lead, it readily fuses, forming a transparent yellowish colored glass.

Gypsum. Calcium sulphate is found in nature in a number of different forms, the most common of which is gypsum ($CaSO_4 . 2H_2O$). It is used in many industries, such as in building and sculpture, and in making plaster of Paris. In agriculture it serves as a fertilizer.

Iron Oxides. Iron oxide is found in a variety of colors, varying from black to purple. It is present in some form in many clays and is a deciding influence toward fusibility in the common clays. It lends a red color to the average clay when fired and is carefully avoided by the manufacturers of white ware.

In glaze preparation, iron oxide is used with other oxides to get various shades of the same color. By itself it forms a pale, undecided yellow.

Litharge (PbO). Litharge is prepared by heating lead and letting it oxidize in the air at a temperature of a little less than 1000 deg. The color generally is a soft yellow. It is used in glassmaking and in preparing yellow compounds for glaze making.

Manganese Carbonate ($MnCO_3$). Manganese is found in nature chiefly in the form of the dioxide (MnO_2) which goes under the name of pyrolusite. In glaze preparation, its chief use is in the form of a colorant, and provides shades all the way from a light purple to almost a black. Though the oxide form can be used, the carbonate preparation is more satisfactory.

Nickel (Ni). As was stated earlier, cobalt and nickel are nearly always found together. The chief mining deposits of nickel are at Sudbury, Ontario, and the Islands of New Caledonia, which belong to the French. Nickel oxide (Ni_2O_3) has been proved useful in preparing greens, grays, and blacks.

Pink Oxide. This is a patented color prepared from chromium. It can be obtained from leading ceramic dealers.

Plaster of Paris ($CaSO_4$). Plaster of Paris is made by heating gypsum rock and then grinding the mass into a fine powder. Plaster of Paris is the casting plaster widely used in the pottery industry for making molds. Casting plaster is ground finer and is prepared by grinding the calcined gypsum twice instead of once. Casting plaster sets quickly and must be used soon after mixing.

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Red Lead (Pb_3O_4). Red lead is prepared by heating litharge to

about 450 deg. in contact with a current of air. This turns the mixture to a beautiful red color, whence its name "red lead." Industrially, red lead is most widely used as a pigment for painting. In pottery making, red lead is used more often than litharge in the preparation of the yellow-base compound.

Tin Oxide (SnO_2). Tin oxide has been used for several centuries to give opacity to glaze. From its use we get the term enamel, which means an opaque glaze.

Umber, Burnt. Umber is an earthly colorant found in cypress. It can be obtained from any reliable paint-selling firm. Used in the calcined form, umber will give a variety of brown colors when added to the glaze base.

Uranium Oxide (U_3O_8). Both black and orange uranium oxide may be used to produce orange and yellow colors in lead glazes. From 5 to 10 per cent is a good proportion for a trial.

White Lead, Lead Carbonate ($2PbCO_3.Pb(OH)_2$). When fired, white lead becomes lead oxide, and is so called even though it is in the carbonate group. It is used as the chief fluxing base for the raw glazes. When well balanced with a number of other chemicals, white lead makes an interesting glaze, though it has a number of decided faults. It is poisonous and should be handled with care, and it is destructive of a number of colors which might otherwise be readily used. It devitrifies under an intense heat so that it cannot be used where the temperature is great.

Zinc Oxide (ZnO). This is a white powder and is obtained by heating the zinc ore in a current of air, or by the oxidization of the metal itself. It is used widely as a pigment for paint, and in the pottery industry to brighten the colors in the glaze. Care must be taken, however, not to overuse zinc oxide, as it will prove disastrous to the glaze base.

Bats. These are plaster slabs made in various shapes upon which the clay is placed while the work is going on. By keeping these blocks of plaster wet, the clay is preserved in a damp state.

Biscuit. Fired pieces of pottery before they are glazed are called biscuits. The unfired objects are generally called green shapes or green pieces.

Crazing. The fine cracks which form upon the surface of some glazed pieces is called crazing. It is an indication that there is an in-

herent disagreement between the body of the ware and the glaze. If the body is porous, water will leak out through these fine cracks and in time cause a dirty unattractive appearance. If the glaze cannot be remedied, the body should be fired as near to the vitrification point as possible or the clay will be changed entirely. To save the pieces made, warm and rub with smoking-hot paraffin.

Earthenware. This is a ware first produced in England toward the end of the eighteenth century and intended as an imitation or rival to porcelain. It consists of a white, burning paste composed of plastic clay with some quartz and feldspar mixed in. At times, it also contains a percentage of kaolin.

Maiolica or Majolica. A type of pottery coated with an opaque tin glaze or enamel. The name came into use in the fifteenth century and was given to luster ware imported on Majorcan trading ships. It was, thus, mistakenly supposed to have been manufactured in Majorca.

Mixtures for High-Temperature Ware. Some beginners may be interested in trying their hand at the production of high-temperature ware. Until some experience has been gained, it is well to start out with earthenware, and after becoming familiar with the conditions under which it may be worked, to try soft porcelain mixture.

Earthenware will be found to be creamy and porous under a moderately high temperature, while porcelain will need a hard fire and will only be well fired when it becomes white and translucent.

Earthenware Mixture	*Lb.*	*Porcelain*	*Lb.*
Ball clay	35	Feldspar	25
Kaolin	20	Kaolin	40
Flint	30	Flint	35
Feldspar	15		

If the units of pounds are too large, any smaller unit may be used. Different types of ware also can be made by changing the quantities of either fusible or nonfusible materials. The earthenware mixture is very good for patching cracks in biscuit-fired pieces which are only slightly damaged and which can be filled and glazed.

Oxidizing Flame. There are two methods of controlling the flames in a furnace. One is by oxidization, in which all the air necessary for complete combustion is used, and the other is by reduction, in which the air is partly shut off so that as the action of combustion goes on, the

flames take the oxygen from the ware itself. Reducing flames are used largely to produce odd colors and fine luster effects.

Porcelain. This is a kind of pottery, the chief characteristic of which is vitrification and translucency. Unlike pottery, porcelain is made from a mixture of substances called a paste, and is not made from the original clay alone.

Pottery. The word *pottery,* in the most general sense of the term, includes all objects made from clay, and hardened by contact with fire. It is, however, usually distinguished from other types of ware by the fact that it is made from the original clay with comparatively little alteration of that material.

Slurry. Water and clay, before screening, is called slurry, and after screening it takes the name of slip.

TABLES OF WEIGHTS

Avoirdupois

1 lb. =	16 oz. = 7000 grains
1 lb. =	453.39 grams
1 oz. =	28.35 grams
1 oz. =	437.5 grains

Troy

1 lb. =	12 oz. = 5760 grains
1 lb. =	373.24 grams
1 oz. =	31.1 grams
1 oz. =	480 grains

Metric

1 gram =	15.432 grains
1 gram =	.03216 oz. Troy
1 gram =	.03527 oz. Avoirdupois

STANDARD PYROMETRIC CONES[1]

Temperature Equivalents of Cones

The Soft Series

Cone Number	When fired slowly 20° C per hour — Cent.	° Fahr.	When fired rapidly 150° C per hour — ° Cent.	° Fahr.
022	585	1085	605	1121
021	595	1103	615	1139
020	625	1157	650	1202
019	630	1166	660	1220
018	670	1238	720	1328
017	720	1328	770	1418
016	735	1355	795	1463
015	770	1418	805	1481
014	795	1463	830	1526
013	825	1517	860	1580
012	840	1544	875	1607
011	875	1607	905	1661

The Low-Temperature Series

Cone Number	When fired slowly 20° C per hour — ° Cent.	° Fahr.	When fired rapidly 150° C per hour — ° Cent.	° Fahr.
010	890	1634	895	1643
09	930	1706	930	1706
08	945	1733	950	1742
07	975	1787	990	1814
06	1005	1841	1015	1859
05	1030	1886	1040	1904
04	1050	1922	1060	1940
03	1080	1976	1115	2039
02	1095	2003	1125	2057
01	1110	2030	1145	2093

[1] Courtesy of The Edward Orton, Jr., Ceramic Foundation, Columbus, Ohio.

The Intermediate-Temperature Series

Cone Number	*When fired slowly 20° C per hour* ° Cent.	° Fahr.	*When fired rapidly 150° C per hour* ° Cent.	° Fahr.
1	1125	2057	1160	2120
2	1135	2075	1165	2129
3	1145	2093	1170	2138
4	1165	2129	1190	2174
5	1180	2156	1205	2201
6	1190	2174	1230	2246
7	1210	2210	1250	2282
8	1225	2237	1260	2300
9	1250	2282	1285	2345
10	1260	2300	1305	2381
11	1285	2345	1325	2417
12	1310	2390	1335	2435
13	1350	2462	1350	2462
14	1390	2534	1400	2552
15	1410	2570	1435	2615
16	1450	2642	1465	2669
17	1465	2669	1475	2687
18	1485	2705	1490	2714
19	1515	2759	1520	2768
20	1520	2768	1530	2786

The High-Temperature Series

Cone Number	*When heated at 100° per hour* ° Cent.	° Fahr.
23	1580	2876
26	1595	2903
27	1605	2921
28	1615	2939
29	1640	2984
30	1650	3002
31	1680	3056
32	1700	3092
32½	1725	3137
33	1745	3173
34	1760	3200
35	1785	3245
36	1810	3290
37	1820	3308
38	1835	3335
39	1865	3389
40	1885	3425
41	1970	3578
42	2015	3659

CHAPTER XXII

The Joys and Sorrows of Pottery Making

FOR Shakespeare, "all the world is a stage and the men and women merely players," and for each individual life casts a different picture, which is colored largely by the work he performs.

Pottery Making as a Game. Let us think of pottery making as an interesting game with many and varied plays all demanding the best that is within us. It is a game of joys and sorrows, of highly inspirational moments, and of equally depressing periods. The charm of it all is there, however, drawing one onward in the quest of more and newer surprises. Once undertaken, the lure of the work never leaves but draws the individual on until it is practically an obsession. To take a lump of lifeless clay and create from it an object of rare beauty is an art that appeals to the heart of nearly every individual.

Kinds of Work. Pottery production may be carried on in a variety of ways, and the methods used will depend largely upon the personality of the individual, his tastes and inclinations, and the demands which his workaday life makes upon him. The production may be along the lines of cooking vessels needed for the home, such as bean pots, teapots, mixing bowls, salad bowls, mush dishes, waffle pitchers, jugs, flowerpots, and the like, or he may have the leisure and the desire to create other articles of beauty but perhaps of less immediate use value.

Again the desire may be to produce a substantial but inexpensive type of pottery, which may be sold in mass to a wide range of customers, or the dream may be to produce the highly artistic ware demanding in every line and curve the touch of the artist's hand.

Beyond this highly artistic ware, the dreams may go to the field of high-temperature ware with its wonderful hard pastes and rare textures where the apex of production is reached in the translucent porcelain of the masters. And through it all the joys and sorrows increase in direct proportion to the difficulty of the products made.

Where money is the objective, the cheaper objects manufactured in large quantities will probably pay the best, and where a pride is taken in making an artistic article, the joy of production should not be lacking. However, beauty of form and color should never be sacrificed to the god of money, but should always be kept as an ideal to be sought for in every piece.

In the field of art production, the emotions are more highly played upon by the exacting demands of the work. In the raging flames of the high-temperature ware, many wonderful things develop, bringing a peculiar fascination to the art and moments of wonderful inspiration, but also hours of deep discouragement.

Just Plain, Hard Work. The fact, too, must not be overlooked that just plain, hard work is demanded in the production of practically any object, and that pottery is no exception. The clay must be dug, stored, washed, screened, and thickened, and with all such operations there is bound to be a large amount of hard work. Plaster forms and molds challenge the technical skill of the individual, but again plenty of work enters in and makes its definite demands. Molds do not always come out as they should nor furnish castings as desired, and pieces will break at times in the firing. Glazes, too, provide their share of problems, giving to the individual many hours of study, where every faculty must be on the alert to detect troubles and remedy them.

Fine pottery is more or less of a luxury, so that in periods of economic depression the sales of the ware will fall off decidedly. From the financial side, care must be taken to have a great enough variety in size, cost, utility, and novelty to meet fluctuations of the market. However, an encouraging feature may be found in the fact that good ware has always sold chiefly on its merits and not a widely advertised trade name. Again, the use of pottery products is so basic in all living and so varied that there is practically always a demand for some line of the ware.

It is interesting to note the variety of articles which are possible only by the use of clay. The spark plugs on a car have a type of porcelain in them; the insulators holding the wires in our houses and on the poles, the fixtures in our bathrooms, the drinking fountains in our schools, the tiles in our sinks and floors, the china in our cupboards, the novelties on our tables, all make their demands on clay and clay manufacture. So it is pleasant to be studying and working with a material which has so many and varied possibilities.

All lines of honest endeavor, too, involve a certain amount of drudgery. No individual should hesitate to go into the work of pottery for fear of the manual labor. The demands in this line are no worse than those in other crafts and in many ways the work is interesting.

The profits are not such that the individual will become wealthy, but intelligent work should bring him a good, comfortable living, with an increase in dividends as the business grows.

For the teacher, the work should bring the greatest joy, for it holds a tireless fascination for the student which makes the teacher's task one of constant inspiration and lasting satisfaction. The joy of creation grips all, and to the young person it is unusually appealing, so that he will work tirelessly for the joy of the results attained. Pottery making is a work well worth trying as a teaching subject, as a leisure-time avocation, or as a life vocation. No matter what the approach, the work will be a pleasure.

Suggested Readings

Barber, Edwin Atlee, *Pottery and Porcelain of the United States* (New York: G. Putnam & Sons).

Binns, C. F., *Ceramic Technology* (New York: D. Van Nostrand Co.).

——— *The Potters Craft* (New York: D. Van Nostrand Co.).

Cox, George J., *Pottery* (New York: The Macmillan Co.).

Davidson, Ralph C., *Concrete Pottery and Garden Furniture* (New York: Munn & Co.).

Doat, Taxile, *Frand Feu Ceramics* (Syracuse, N. Y.: Keramic Studio Publishing Co.).

Dougherty, John W., *Pottery Made Easy* (Milwaukee, Wis.: The Bruce Publishing Co.).

Fairie, James, *Notes on Pottery Clay* (New York: D. Van Nostrand Co.).

Gall, Irma M. and Van Etta, Vivian M., *Art of Pottery* (Milwaukee, Wis.: The Bruce Publishing Co.).

Griffin, Henry R., *Clay Glazes and Enamels* (Indianapolis, Ind.: T. A. Randall Co.).

Hainbach, Rudolph, *Pottery Decorating* (London: Scott Greenwood & Son).

Lunn, Richard, *Pottery* (London: Chapman & Hall Co., Ltd.).

Ries, Henrich, *Clay, Occurrences, Properties and Use* (New York: John Wiley & Sons).

Rogers, Allen, *Chemistry, Manual of Industrial Chemistry* (New York: D. Van Nostrand Co.).

Searle, Alfred B., *Clay and What We Get From It* (New York: The Macmillan Co.).

Toft, Albert, *Modeling and Sculpture* (Philadelphia: J. B. Lippincott Co.).

Varnum, Wm. H., *Industrial Arts Design* (Peoria, Ill.: The Manual Arts Press).

Wilson, Hewitt, *Ceramic Clay Technology* (New York: McGraw Hill Book Co.).

Appliances and Materials

Chemicals, Glazes, Stilts, etc.
Braun-Knecht-Heimann Co., San Francisco.
B. F. Drakenfeld & Co., New York.
Roessler & Hasslacher Chemical Co., New York.

Cones
Standard Pyrometric Cones, Edward Orton Jr. Ceramic Foundation, Columbus, Ohio.

Kilns
Amaco Pottery Kilns, The American Art Clay Co., Indianapolis, Ind.
Keramic Pottery Kilns, Denver Fire Clay Co., Denver, Colo.
Perfection Pottery Kilns, B. F. Drakenfeld & Co., New York.
Revelation Pottery Kilns, H. J. Caulkins & Co., Detroit, Mich.

Mills, Ball
Abbey Engineering Co., New York.
Braun-Knecht-Heimann Co., San Francisco.

Plaster of Paris and Casting Plaster
Certain-teed Products Corp., New York.
Henry Cowell Lime & Cement Co., San Francisco.
Calvin Thompkins, Battery Place, New York.
NOTE: Consult your local dealer about plaster.

Pottery Machinery
Andrew Baird, Detroit, Mich.

Pottery Wheels
Crossley Manufacturing Co., Trenton, N. J.

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